5000 Moisture Analyzer with Single Point Analysis

User Manual

PN 500088901 Rev.YB

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Safety Notes

WARNINGS, CAUTIONS, and NOTES contained in this manual emphasize critical instructions as follows:

An operating procedure which, if not strictly observed, may result in personal injury or environmental contamination.

An operating procedure which, if not strictly observed, may result in damage to the equipment.

Important information that should not be overlooked.

Electrical Safety

Up to **240V** may be present in the Analyzer and the Controller. Always shut down power source(s) before performing maintenance or troubleshooting. Only a qualified electrician should make electrical connections and ground checks.

Any use of the equipment in a manner not specified by the manufacturer may impair the safety protection originally provided by the equipment.

Any troubleshooting or maintenance that requires access to the interior of the analyzer must be performed only by qualified personnel. There are no operator-serviceable parts inside the analyzer.

Grounding

Instrument grounding is mandatory. Performance specifications and safety protection are void if instrument is operated from an improperly grounded power source.

Verify ground continuity of all equipment before applying power.

Sample Gas

WARNING

Potential hazards of the sample gas should be taken into consideration before connecting the sample to the analyzer. Personal protective equipment and proper ventilation should be used if sample gas is toxic, flammable, or corrosive. Check the sample line and all connections for leaks before powering up. Consult plant safety personnel for appropriate exhaust venting guidelines for specific sample gas type.

NOTE

The field unit may contain flammable or toxic process gas. Remove the field unit dome lid in a well-ventilated area only after electrical power is removed and the surrounding area is known to be nonhazaradous.

Check the sample system for leaks before connecting to the analyzer.

CAUTION

The lid weighs 8.2kg (18 lb). Use proper lifting methods and wear protective footwear when removing.

NOTE

Follow all operating, calibration, and maintenance procedures in this manual. If output is questionable, check the system immediately for proper function and calibration.

Warning Labels

These symbols may appear on the instrument in order to alert you of existing conditions.

PROTECTIVE CONDUCTOR TERMINAL
(BORNIER DE L'ECRAN DE PROTECTION)
Schutzerde

CAUTION - Risk of electric shock
(ATTENTION-RISQUE DE DÉCHARGE ÉLECTRIQUE)
Achtung - Hochspannung Lebensgefahr

CAUTION - Refer to accompanying documents
(ATTENTION-SE RÉFERER AUX DOCUMENTS JOINTS)
Achtung (Beachten Sie beiliegende Dokumente)

CAUTION - Hot Surface
(ATTENTION-SURFACE CHAUDE)
Achtung - Heiße Oberfläche

Environmental Information (WEEE)

This AMETEK product contains materials that can be reclaimed and recycled. In some cases the product may contain materials known to be hazardous to the environment or human health. In order to prevent the release of harmful substances into the environment and to conserve our natural resources, AMETEK recommends that you arrange to recycle this product when it reaches its "end of life."

Waste Electrical and Electronic Equipment (WEEE) should never be disposed of in a municipal waste system (residential trash). The Wheelie Bin marking on this product is a reminder to dispose of the product properly after it has completed its useful life and been removed from service. Metals, plastics and other components are recyclable and you can do your part by one of the following these steps:

- When the equipment is ready to be disposed of, take it to your local or regional waste collection administration for recycling.
- In some cases, your "end-of-life" product may be traded in for credit towards the purchase of new AMETEK instruments. Contact your dealer to see if this program is available in your area.
- If you need further assistance in recycling your AMETEK product, contact our office listed in the front of the instruction manual.

Electromagnetic Compatibility (EMC)

Read and follow the recommendations in this section to avoid performance variations or damage to the internal circuits of this equipment when installed in harsh electrical environments.

The various configurations of the 5000 Moisture Analyzer (Single Point)should not produce, or fall victim to, electromagnetic disturbances as specified in the European Union's EMC Directive. Strict compliance to the EMC Directive requires that certain installation techniques and wiring practices are used to prevent or minimize erratic behavior of the Analyzer or its electronic neighbors. Below are examples of the techniques and wiring practices to be followed.

In meeting the EMC requirements , the various Analyzer configurations described in this manual rely heavily on the use of metallic shielded cables used to connect to the customer's equipment and power. Foil and braid shielded I/O and DC power cables are recommended for use in otherwise unprotected situations. In addition, hard conduit, flexible conduit, and armor around non-shielded wiring also provides excellent control of radio frequency disturbances. However, use of these shielding techniques is effective only when the shielding element is connected to the equipment chassis/earth ground at both ends of the cable run. This may cause ground loop problems in some cases. These should be treated on a case-by-case basis. Disconnecting one shield ground may not provide sufficient protection depending on the electronic environment. Connecting one shield ground via a 0.1 microfarad ceramic capacitor is a technique allowing high frequency shield bonding while avoiding the AC-ground metal connection. In the case of shielded cables the drain wire or braid connection must be kept short. A two-inch connection distance between the shield's end and the nearest grounded chassis point, ground bar or terminal is highly recommended. An even greater degree of shield performance can be achieved by using metallic glands for shielded cable entry into metal enclosures. Expose enough of the braid/foil/drain where it passes through the gland so that the shield materials can be wrapped backwards onto the cable jacket and captured inside the gland, and tightened up against the metal interior.

Inductive loads connected to the low voltage "Alarm Contacts" are not recommended. However, if this becomes a necessity, adhere to proper techniques and wiring practices. Install an appropriate transient voltage suppression device (low voltage MOV, "Transzorb," or R/C) as close as possible to the inductive device to reduce the generation of transients. Do not run this type of signal wiring along with other I/O or DC in the same shielded cable. Inductive load wiring must be separated from other circuits in conduit by using an additional cable shield on the offending cable.

In general, for optimum protection against high frequency transients and other disturbances, do not allow installation of this Analyzer where its unshielded I/O and DC circuits are physically mixed with AC mains or any other circuit that could induce transients into the Analyzer or the overall system. Examples of electrical events and devices known for the generation of harmful electromagnetic disturbances include motors, capacitor bank switching, storm related transients, RF welding equipment, static, and walkie-talkies.

SPECIAL WARNINGS AND INFORMATION FOR USE IN HAZARADOUS lOCATIONS

5000 CONTROLLER

This Equipment is suitable for use in Class I, Division2, Groups A,B,C,D, ATEX Zone 1, or Non-Hazaradous areas only.

Explosion Hazard - Substitution of Components May Impair Suitability for Class I, Division 2.

Risque d'explosion - La substitution de composants peut rendre ce materiel inacceptable pour les emplacements de Classe I, Division 2.

Explosion Hazard - Do Not Disconnect Equipment Unless Power Has Been Switched Off or the Area is Known to be Non-Hazardous.

Risque d'explosion - Avant de déconnecter l'équipement, coupez le courant où vous assurez que l'emplacement est designé non dangereux.

5000 FIELD UNIT

To reduce the risk of ignition of hazaradous atmospheres, disconnect the equipment from the supply circuit before opening. Keep assembly tightly closed when in OPERATION.

To reduce the risk of ignition of hazaradous atmospheres, conduit runs must have a sealing fitting connected within 18 inches of the enclosure.

When 5000 systems include EEx Sample s/ystem components Special conditions for safe use:

The special conditions for safe use given in the Europesn certificates mentoned in the manufacturer technical file are still relevant. Be aware of special instructions and warnings on all sample system components.
When an IS type option is provided, proper grounding, selection of certified barriers, energy considerations, and use of accepted wiring methods is the responsibility of the end user / installer. See manufacturer's certificate for entity parameters. Refer to section 501.4(b) of the NEC or 18-152 of the CEC for proper wiring connections to the service and installation accessible field terminals on the customer wiring module to energize motors, pumps, or any other device that could present and overload condition during normal operation.
Refer to Customer Wiring Diagrams and Installation Instructions contained in this manual and the customer document package.

WARRANTY AND CLAIMS

We warrant that any equipment of our own manufacture or manufactured for us pursuant to our specifications which shall not be, at the time of shipment thereof by or for us, free from defects in material or workmanship under normal use and service will be repaired or replaced (at our option) by us free of charge, provided that written notice of such defect is received by us within twelve (12) months from date of shipment of portable analyzers or within eighteen (18) months from date of shipment or twelve (12) months from date of installation of permanent equipment, whichever period is shorter. All equipment requiring repair or replacement under the warranty shall be returned to us at our factory, or at such other location as we may designate, transportation prepaid. Such returned equipment shall be examined by us and if it is found to be defective as a result of defective materials or workmanship, it shall be repaired or replaced as aforesaid. Our obligation does not include the cost of furnishing any labor in connection with the installation of such repaired or replaced equipment or parts thereof, nor does it include the responsibility or cost of transportation. In addition, instead of repairing or replacing the equipment returned to us as aforesaid, we may, at our option, take back the defective equipment, and refund in full settlement the purchase price thereof paid by Buyer.

Process photometric analyzers, process moisture analyzers, and sampling systems are warranted to perform the intended measurement, only in the event that the customer has supplied, and AMETEK has accepted, valid sample stream composition data, process conditions, and electrical area classification prior to order acknowledgment. The photometric light sources are warranted for ninety (90) days from date of shipment. Resale items warranty is limited to the transferable portion of the original equipment manufacturer's warranty to AMETEK. If you are returning equipment from outside the United States, a statement should appear on the documentation accompanying the equipment being returned declaring that the goods being returned for repair are American goods, the name of the firm who purchased the goods, and the shipment date.

The warranty shall not apply to any equipment (or part thereof) which has been tampered with or altered after leaving our control or which has been replaced by anyone except us, or which has been subject to misuse, neglect, abuse or improper use. Misuse or abuse of the equipment, or any part thereof, shall be construed to include, but shall not be limited to, damage by negligence, accident, fire or force of the elements. Improper use or misapplications shall be construed to include improper or inadequate protection against shock, vibration, high or low temperature, overpressure, excess voltage and the like, or operating the equipment with or in a corrosive, explosive or combustible medium, unless the equipment is specifically designed for such service, or exposure to any other service or environment of greater severity than that for which the equipment was designed.

The warranty does not apply to used or secondhand equipment nor extend to anyone other than the original purchaser from us.

THIS WARRANTY IS GIVEN AND ACCEPTED IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION AND WARRANTIES OF FITNESS OR OF MERCHANTABILITY OTHER THAN AS EXPRESSLY SET FORTH HEREIN, AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON OUR PART. IN NO EVENT SHALL WE BE LIABLE UNDER THIS WARRANTY OR ANY OTHER PROVISION OF THIS AGREEMENT FOR ANY ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES, CONSEQUENTIAL DAMAGES, TIME CHANGES OR ANY OTHER LOSSES INCURRED BY THE ORIGINAL PURCHASER OR ANY THIRD PARTY IN CONNECTION WITH THE PURCHASE, INSTALLATION, REPAIR OR OPERATION OF EQUIPMENT, OR ANY PART THEREOF COVERED BY THIS WARRANTY OR OTHERWISE. WE MAKE NO WARRANTY, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF FITNESS OR OF MERCHANTABILITY, AS TO ANY OTHER MANUFACTURER'S EQUIPMENT, WHETHER SOLD SEPARATELY OR IN CONJUNCTION WITH EQUIPMENT OF OUR MANUFACTURE. WE DO NOT AUTHORIZE ANY REPRESENTATIVE OR OTHER PERSON TO ASSUME FOR US ANY LIABILITY IN CONNECTION WITH EQUIPMENT, OR ANY PART THEREOF, COVERED BY THIS WARRANTY.

OVERVIEW

The AMETEK 5000 Moisture Analyzer system measures trace concentrations of moisture in gases such as hydrogen, natural gas, air, oxygen, carbon dioxide, and nitrogen. Moisture concentration in the sample gas is quantified in parts-per-million by volume (ppmv) or pounds-per-million cubic feet (lbs/mmft^3) or dewpoint.

Theory of Operation

Cell Frequency

The analyzer measures the oscillation frequencies of two crystal oscillators: Y_1, the local oscillator or LOC, with a constant frequency (nominal f_1 = 8.982500 MHz) and Y_2, the measuring oscillator with a variable frequency (nominal f_2 = 8.982000 MHz). The measuring oscillator contains a crystal which is coated with a thin film of hygroscopic material and enclosed in a measuring cell. When the sample or reference gas flows through the cell, the crystal coating sorbs or desorbs moisture, thereby changing the natural oscillation frequency of the measuring crystal. The difference between the constant and measurement oscillation frequencies is known as the cell frequency.

Wet cell frequency

A typical measurement cycle (»60 seconds) is divided into two »30 second measurement periods*. During the first period of the cycle, sample gas flows through the measuring cell. Moisture sorbed by the crystal coating increases the mass of the crystal which changes the measuring frequency. The measuring frequency (f_2) is continuously mixed with the reference frequency (f_1) to produce the "wet" cell frequency, f_{sample}.

Dry cell frequency

During the second period of the cycle, reference gas (moisture concentration < 1ppm) flows through the measuring cell. Moisture desorbed by

the crystal coating decreases the mass of the crystal which changes the measuring frequency. The measuring frequency (f_2) is continuously mixed with the LOC frequency (f_1) to produce the "dry" cell frequency, f_{ref}. The Df between f_{sample} and f_{ref} is proportional to the moisture content of the sample gas and is used in the polynomial expression used to calculate moisture content.

Like the first cycle, the second cycle starts with the f_{sample} measurement. The D between the second cycle f_{sample} and first cycle f_{ref} measurements becomes the new Df. Then the second cycle f_{ref} measurement is made and the D between the second cycle f_{sample} and second cycle f_{ref} measurements becomes the new Df. In this manner, the value of Df is updated and sample moisture concentration is calculated twice per cycle or approximately every 30 seconds*.

The 5000 Controller accepts inputs from the analyzer and converts them into outputs of value to the user. All analyzer functions are microprocessor-controlled. Operating parameters are set and changed using the 18-key keypad. Continuously updated moisture analysis data, system operating parameters, and system messages are displayed on a 4-line x 80-character display. Controller outputs include two 4 to 20 mA analog signals and three alarm contacts. An RS-485 serial port is also provided on the controller to facilitate remote communication using a personal computer and networking of numerous analyzers.

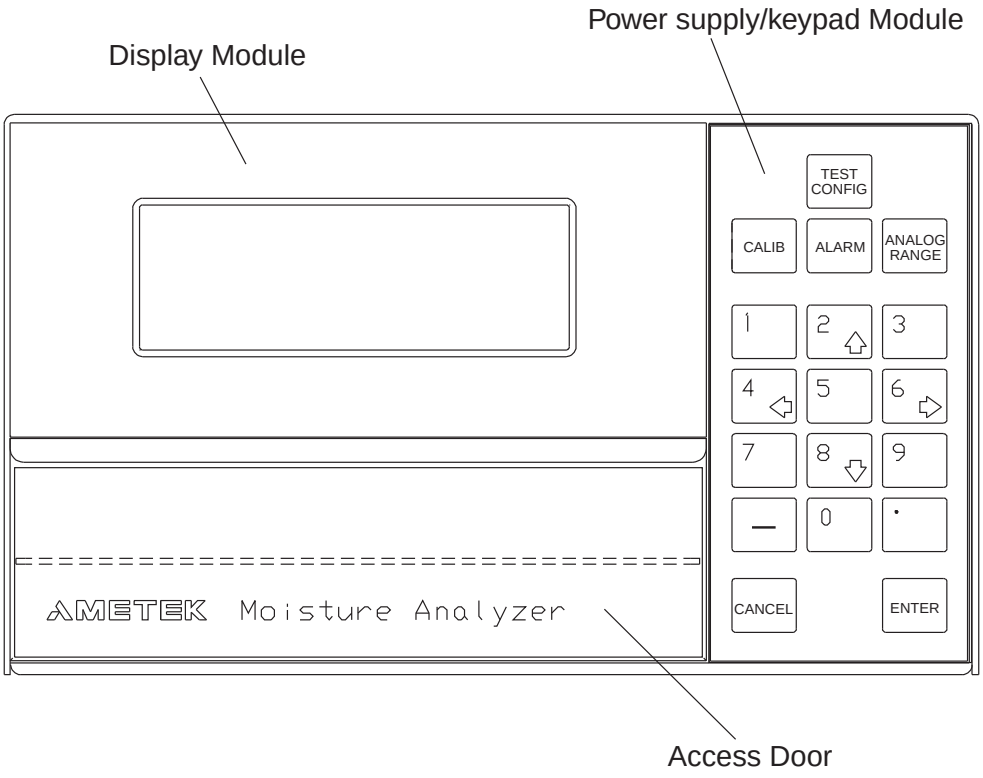

Figure 1-1. Front view of 5000 controller.

* *Timing for typical 5000 system only. Refer to Appendix B for timing of units with asymmetric cycle.*

Verification

A portion of the reference gas flows through a moisture generator where a known amount of moisture is sorbed by the gas. During normal operation, this moisture generator gas is exhausted. When cell verification is required, the moisture generator gas flows through the cell in place of the sample gas. The Δf between the cell frequency measurement made while the moisture generator gas flows through the cell (f_{cal}) and f_{ref} becomes the new Δf. This value, or the resulting moisture value (ppmv), is compared to the known quantity of moisture added to the reference gas by the moisture generator. Cell verification factor (or span) is then verified or can be adjusted as required.

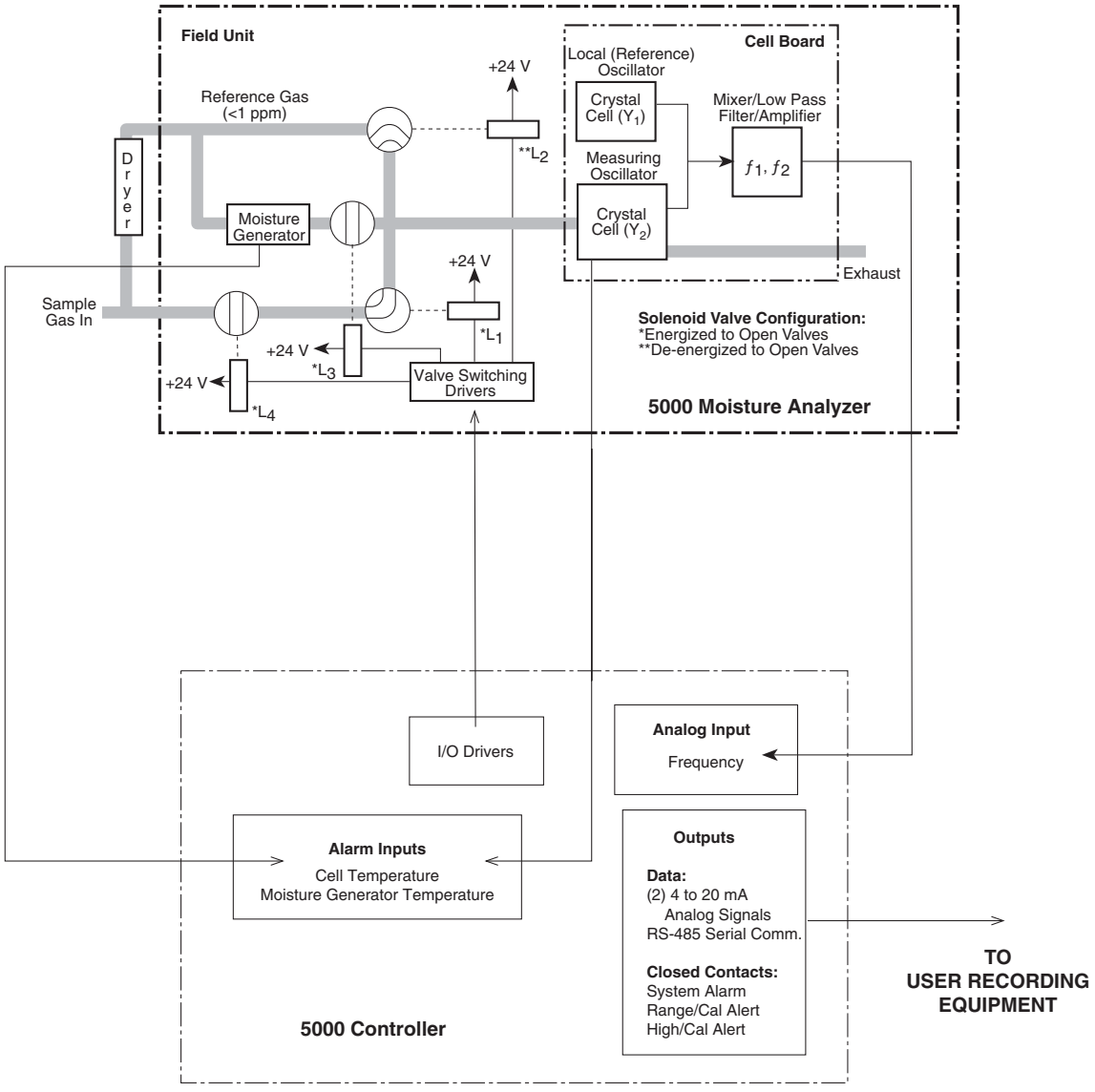

Figure 1-2.
5000 Moisture Analyzer block diagram.

Gas Flow

Gas flows in three separate streams through the system:

- sample gas
- reference gas
- moisture generator gas

Flow rate through the cell (for whichever gas is present) is controlled by flow control needle valves and indicated by a flowmeter at the cell exhaust. A pressure gauge is also located at the exhaust port to ensure analyzer operation at a back pressure of 103 kPa (15 PSI) gauge; this permits exhausting to a pressurized vent.

Four solenoid valves (L_{1-4}) are switched by the controller to control gas flow to the cell as described below.

Energized valves are in the normally closed contacts (NC) position and de-energized valves are in the normally open contacts (NO) position.

Normal operation:

Sample gas flow (f_{sample} measurement)

L_1 is energized and L_4 is de-energized so sample gas flows to the cell. L_2 and L_3 are de-energized (open contacts) so reference **and** moisture generator gases are exhausted.

Reference gas flow (f_{ref} measurement)

L_3 and L_4 remain de-energized. L_1 and L_2 toggle such that reference gas flows through the cell and sample gas is exhausted.

Auto or manual verification:

Moisture Generator gas flow (f_{cal} measurement)

L_3 and L_4 are energized so sample bypasses L_1 to exhaust port and calibration gas flows to L_1. L_1 is energized so moisture generator gas flows to the cell. L_2 is de-energized so reference gas is exhausted.

Reference gas flow (f_{ref} measurement)

L_3 and L_4 remain energized. L_1 and L_2 toggle such that reference gas flows through the cell and moisture generator gas is exhausted.

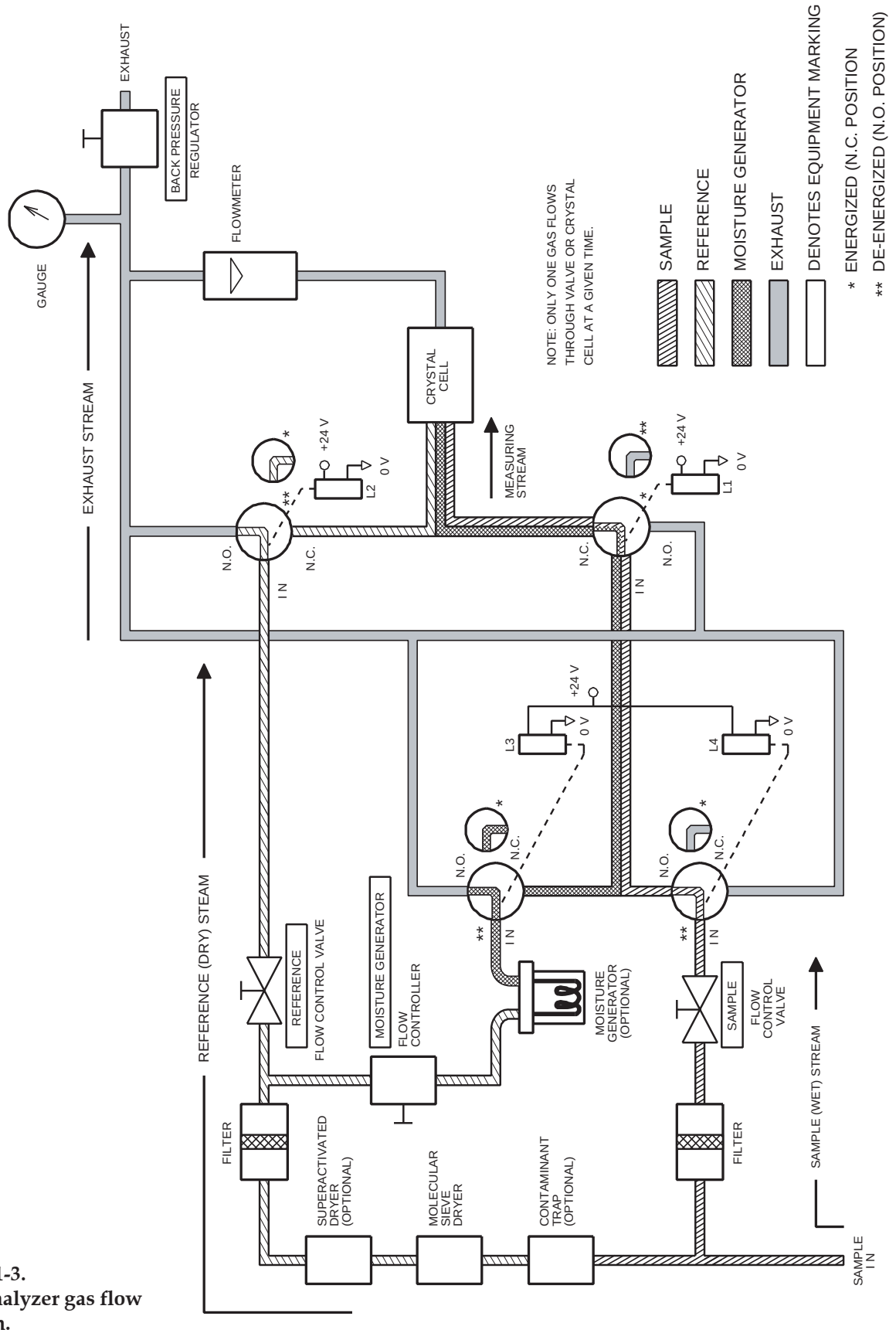

Figure 1-3.
5000 Analyzer gas flow diagram.

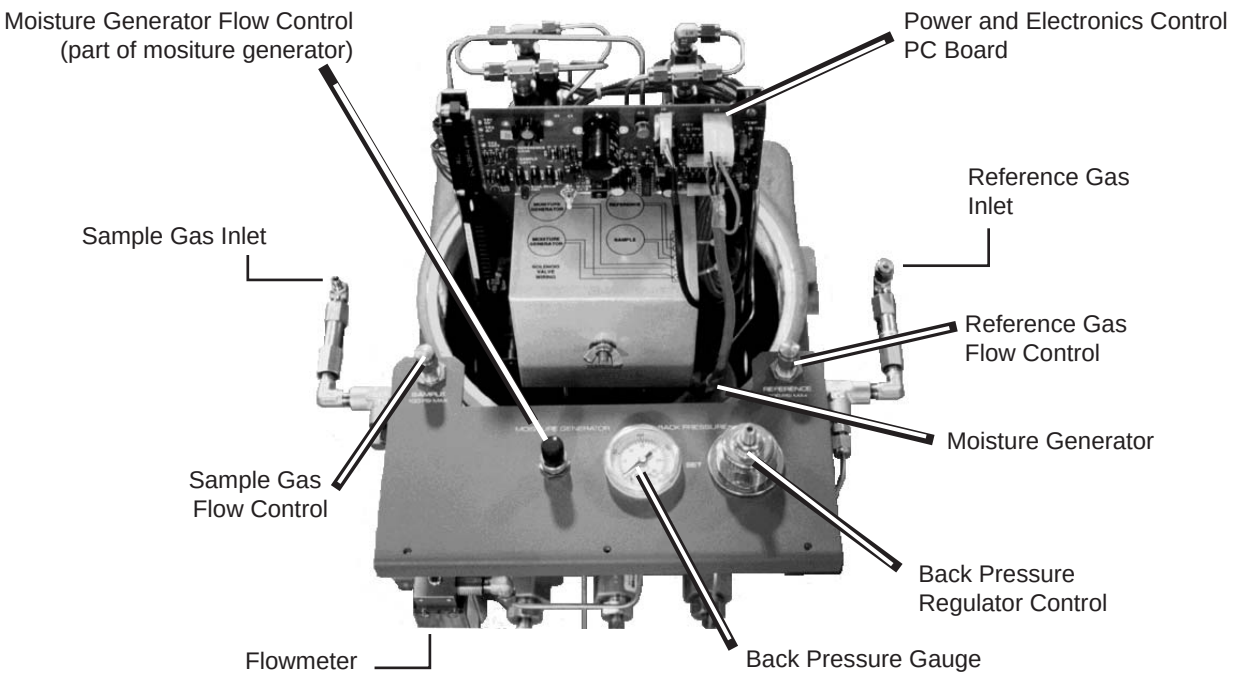

Figure 1-4a.
Top view - typical 5000 field unit.

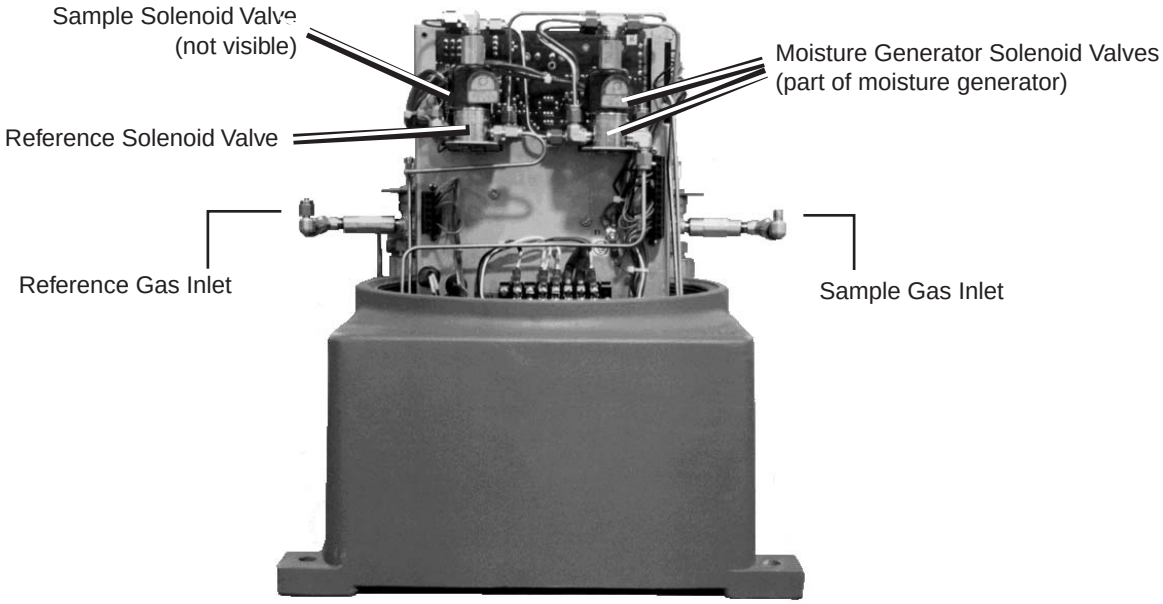

Figure 1-4b.
Back view - typical 5000 field unit.

System Components

A typical 5000 Moisture Analyzer system consists of an explosion-proof 5000 field unit, sample drying and filtering equipment, and a remote 5000 microprocessor controller.

Field Unit

Components contained in the field unit (Figures 1-4a and 1-4b) are:

- Sample cell contained in an oven and maintained at 60 °C
- Sample and reference solenoid valves (L_1, L_2)
- Moisture generator
- Moisture generator solenoid valves (L_3, L_4)
- Power and electronics control card
- Power transformer (not shown)
- Internal heater and 40 °C thermostat (not shown)
- H_2S scrubber (optional)

Externally mounted controls and indicators:

- Sample gas flow control
- Reference gas flow control
- Moisture generator flow control
- Flowmeter
- Back pressure regulator control
- Back pressure gauge

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SPECIFICATIONS

Model 5000 Single-Point Analyzer

Ranges

- Calibrated 0 to 1000 parts per million by volume (PPMV)
- Display continues to provide trend information above 1000 PPMV.
- Output capability in lb/MMscf and dewpoint (Dewpoint output requires sample line pressure as an input; single point systems only).

Sensitivity

0.1 PPMV or 0.5% of reading, whichever is greater.

Accuracy

1.0 PPMV (0.05 lb/MMscf) or 5% of reading, whichever is greater. A super-activated dryer is required for operation below 5 PPMV.

Reproducibility

0.2 PPMV or 1% of reading, whichever is greater. A super-activated dryer is required for operation below 5 PPMV.

Moisture Generator Value

Standard: 20 PPMV (typical ± 10%)
Low Option: 3 PPMV (typical ± 10%)

Allowable Inlet Pressure

207 to 690 kPa gauge (30 to 100 PSIG)

Operating Pressure

103 kPa gauge (15.0 PSIG)

Gas Flow Requirements

250 mL/min each at 103 kPa gauge (15 PSIG) for sample, reference, and moisture generator.

Outputs

- 80-character vacuum fluorescent display
- Two 4 to 20 mA DC analog signals with completely user-defined span; one analog output is auto-ranging
- RS-485 bidirectional serial port

Alarm Contacts

- System Alarm
- Concentration Alert
- Range or Verification Alert
  (Contacts rated 30 VAC / 60 VDC, 50 VA maximum, 1A maximum, resistive)

Maximum Separation

600 meters (2000 ft.) between field unit and controller.

Environmental Conditions

Ambient temperature:	Field Unit:	–20° to 50 °C (-4° to 122 °F)*
	Controller:	–10° to 50 °C (14° to 122 °F)
Relative humidity:	Field Unit:	N/A, internally heated
	Controller:	95% maximum noncondensing

Pollution Degree 2

Maximum altitude 2000 meters (6560 feet)

Installation Category II

Weather Rating

Field Unit:	Indoor/Sheltered/Protected Outdoor Use—IEC 529; IP56
Controller:	Indoor Use—IEC 529; IP40
Enclosure (If Supplied):	Indoor/Outdoor Use—NEMA 4X, IEC 529; IP66

Utility Requirements

All systems are available with choice of nominal AC voltages:

Field Unit:
- 100V ±10%, 50/60 Hz, 175W max.
- 115V ±10%, 50/60 Hz, 175W max.
- 230V ±10%, 50/60 Hz, 175W max.

Controller:
- 95–230V ±10%, 47-63 Hz, 75 W max.

Net Weights

Field Unit:	34 kg (75 lb)
Controller:	~6 kg (13 lb)
External 3A Molecular Sieve Dryer:	8 kg (18 lb)
Super-activated Dryer:	8 kg (18 lb) *optional*
Contaminant Trap:	8 kg (18 lb) *optional*

* *Unless ordered as an extended range configuration.*

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INSTALLATION

Read this section of the manual before beginning installation of the Model 5000 analyzer system. Failure to do so may impair the protection against fire, electrical shock, and personal injury originally provided for by this equipment. In addition, failure to follow the installation and start-up instructions may void the instrument's warranty.

Prior to Installation

The 5000 Field Unit is approved for the following hazardous area classifications:

- Class I; Group B, C, D; Division 1 as defined by the U.S. National Electrical Code (NEC) and
- Zone 1.

The Model 5000 analyzer system is typically installed with the field unit near the sample tap (normally in a hazardous area) and the 5000 controller located in a control room. The controller is suitable for installation in NEC Class 1 ; Groups A, B, C & D; Division 2 areas. The field unit and controller may be separated by up to 600 meters (2000 feet). Prior to installation, a site plan should be prepared defining the mounting locations of the field unit, controller, and sample system components. The plan should also detail the AC input(s), interconnect wiring, and sample line routing.

Unpacking and Inspection

Remove components from the packing case(s) carefully and check contents against packing list. Inspect all components for obvious damage and broken/ loose parts or fittings. Notify the carrier and **AMETEK Service (1-800-537-6044)** immediately if parts are missing or damage is found.

Field Unit Installation

Figure 3-1 shows installation dimensions for standard (Division 1 and 2) and CENELEC versions of the field unit. Locate the field unit as near as possible to the sample tap and bolt into place. The unit should be protected from direct exposure to weather and located so that the ambient temperature specifications will not be exceeded.

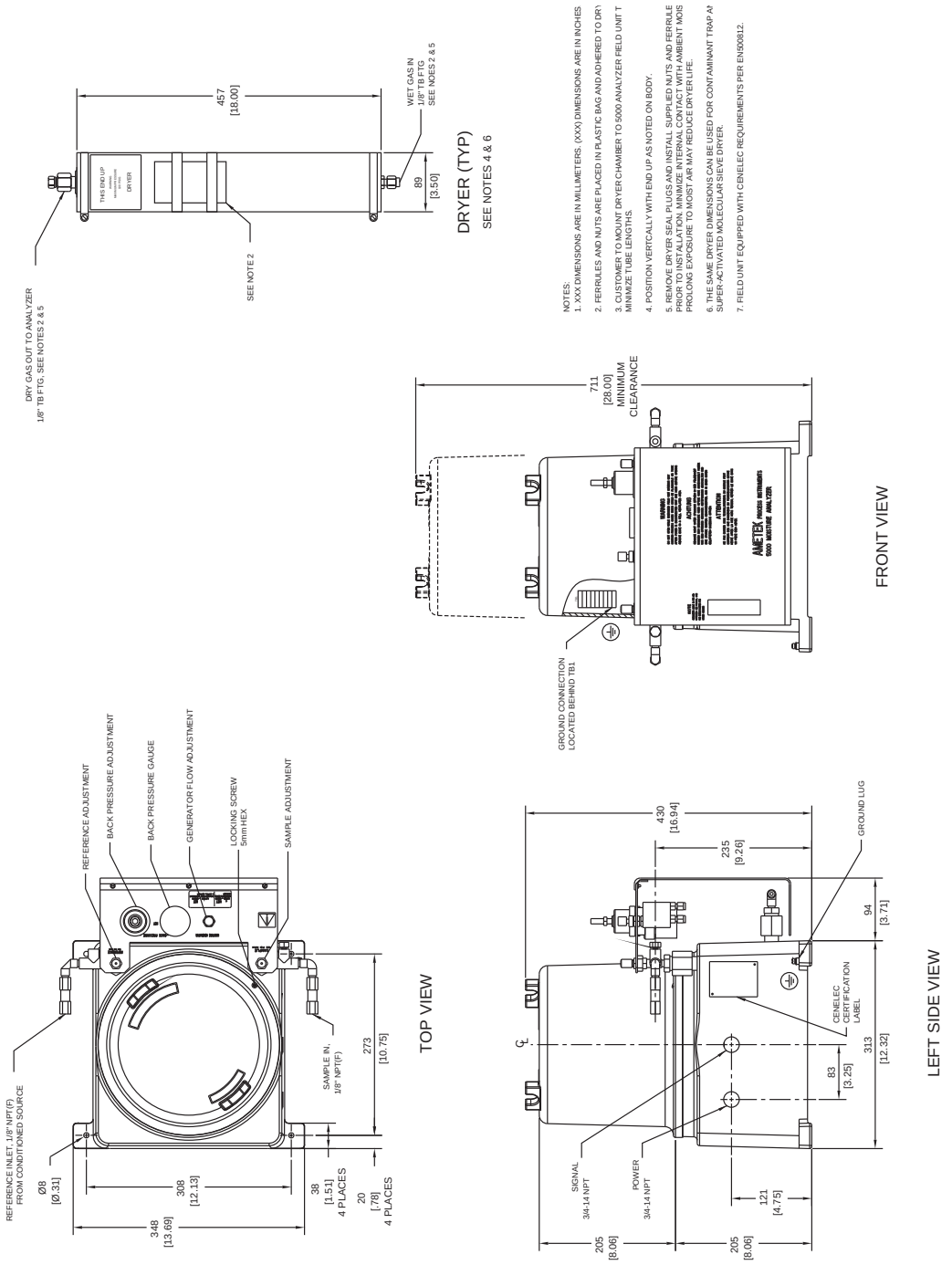


Figure 3-1.
Installation / dimensional layout for Model 5000 field unit (CENELEC).

Controller Installation

Mount the controller indoors in desired location and bolt in place. Figures 3-2a through 3-2e show installation dimensions for all controller mounting configurations.

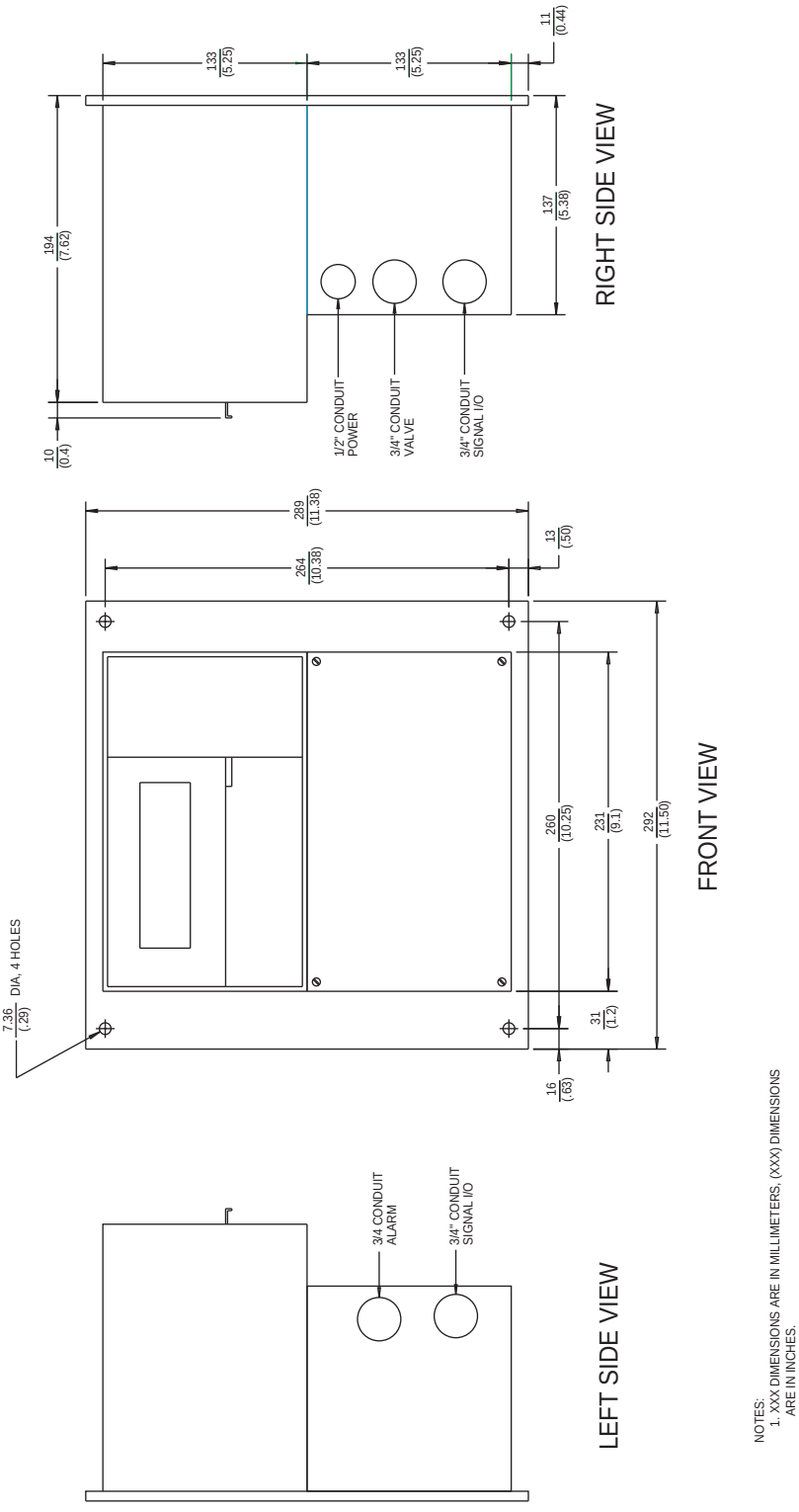


Figure 3-2a.
Surface Mounted Model 5000 controller.

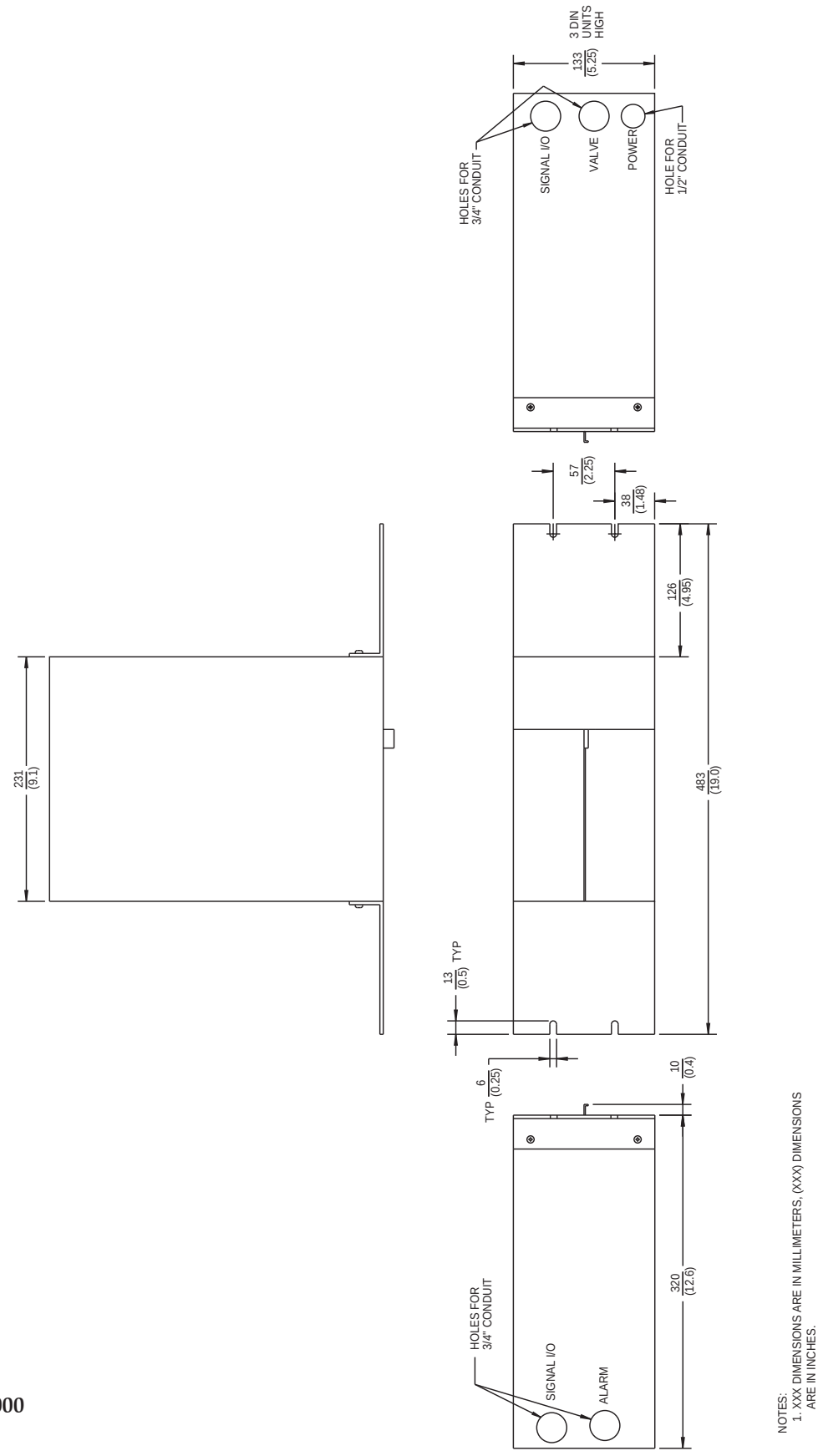


Figure 3-2b.
19 inch (~48.26 cm) rack Mount Model 5000 controller.

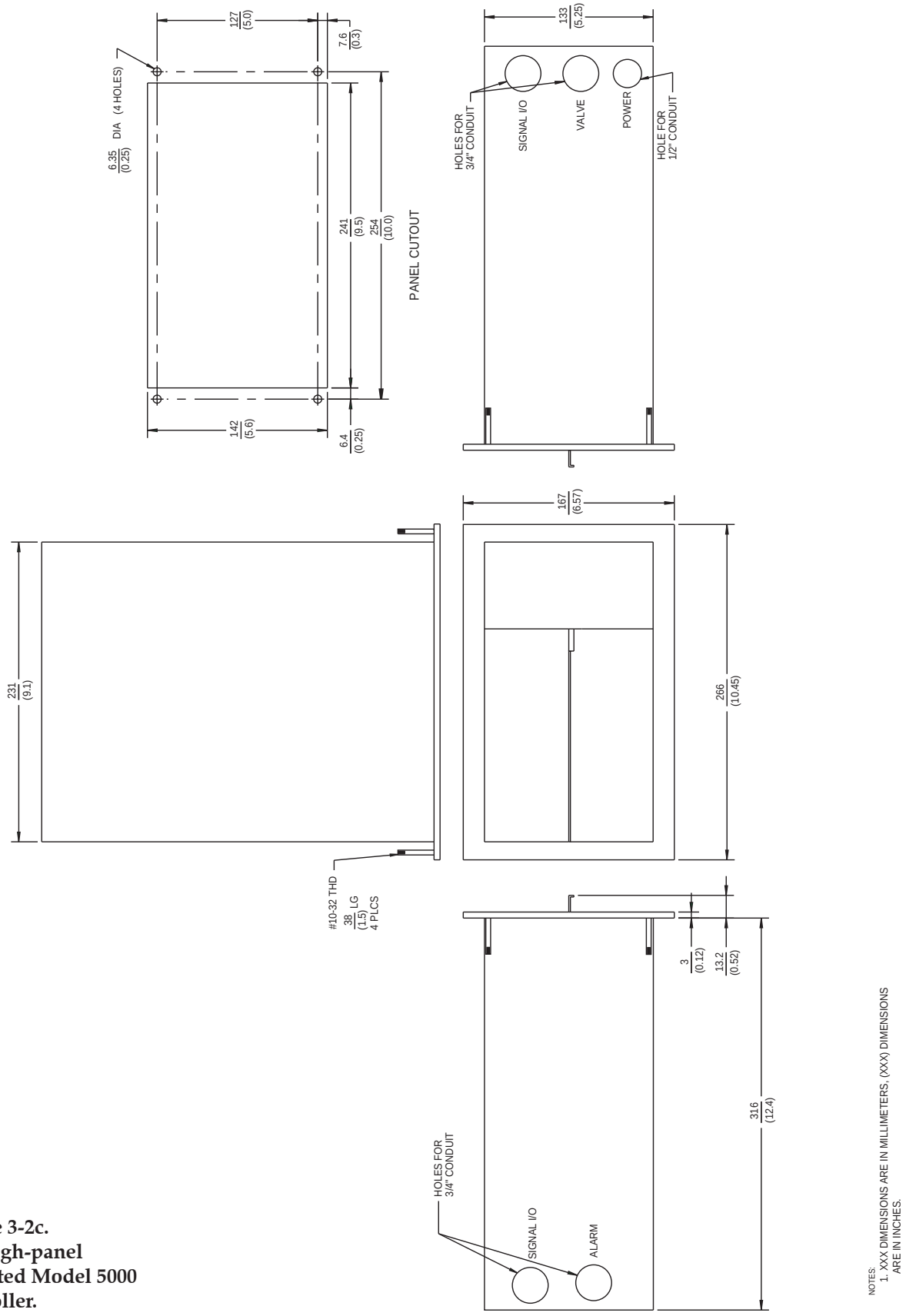


Figure 3-2c. Through-panel mounted Model 5000 controller.

NOTES:
1. XXX DIMENSIONS ARE IN MILLIMETERS, (XXX) DIMENSIONS ARE IN INCHES.

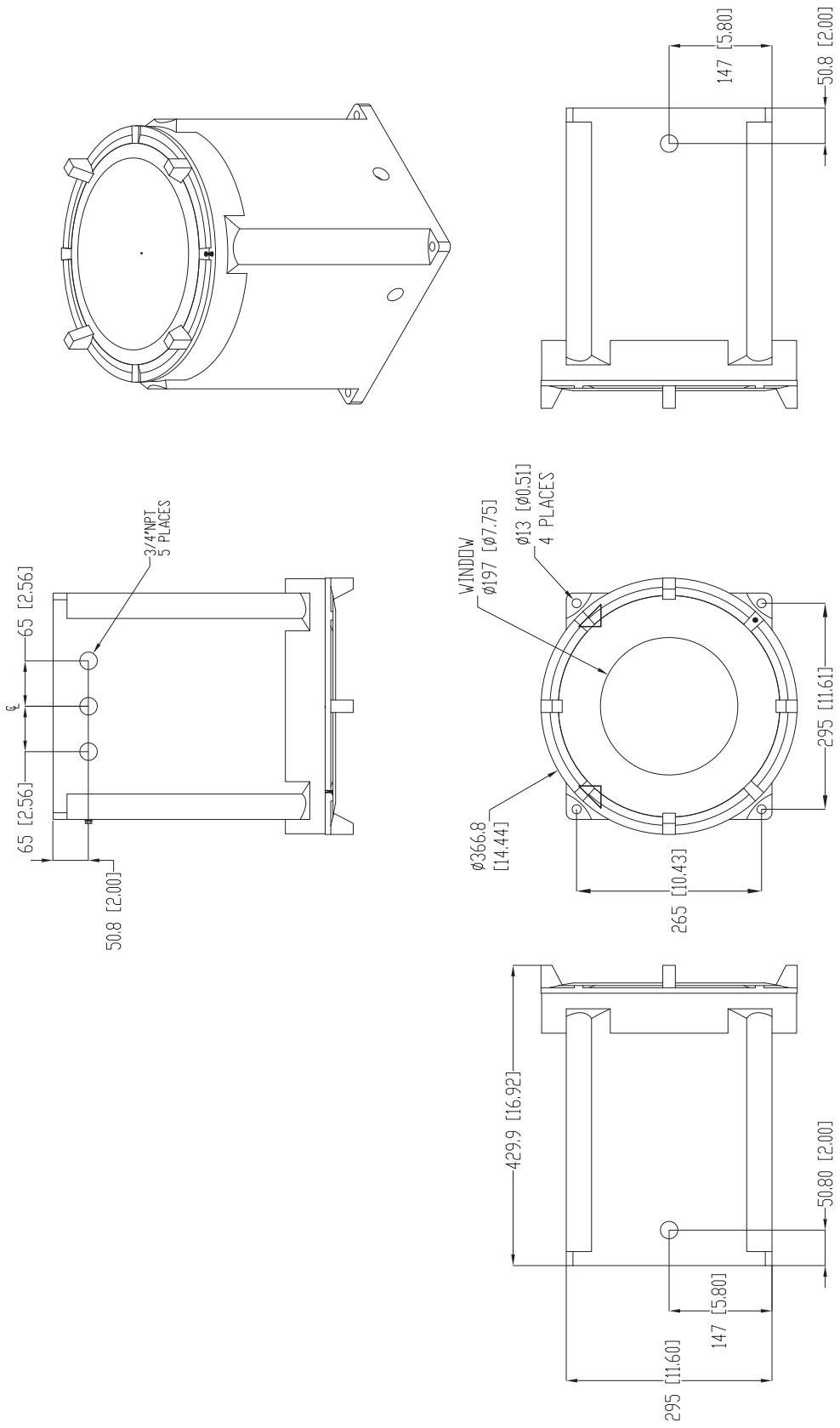


Figure 3-2e.
Model 5000 Enclosure (ATEX Zone 1).

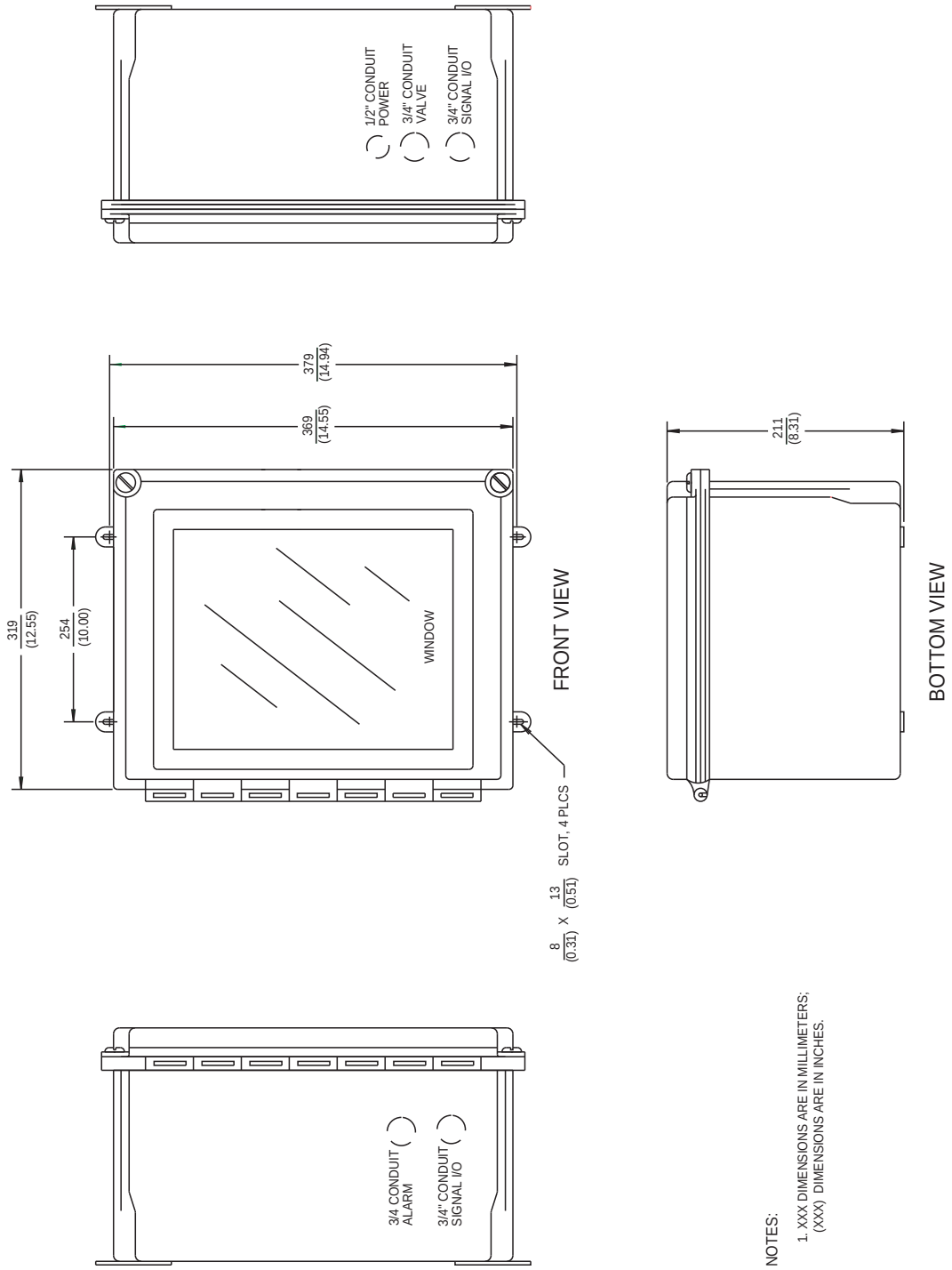


Figure 3-2d.
Surface mounted Model 5000 controller in NEMA 4X enclosure.

Refer to the Customer Drawing (CD) package accompanying this manual for 5000 system interconnect wiring configuration and for 5000 controller back plane terminal locations.

Power Requirements

The Model 5000 system components are shipped according to the customer order and are fused and set for the voltage of the required mains power. The power requirements are stated near the power entry for the component and in Chapter 2 of this manual. Supplemental information may appear in the Customer Drawing (CD) package.

The 5000 Field Unit is fused internally with a 1-Amp fuse for nominal 230 VAC applications, and 2-Amp for 100 and 115 VAC. The rupture speed is either a type M or T (slow blow). The voltage is set by specific wiring in the unit. Information on the various wiring configurations is contained in the CD package.

The 5000 Controller uses a universal DC switching power supply and will accommodate a voltage range of 85 to 265 VAC. The power supply has an on-board fuse which serves as the controller's power protection at any voltage in the range.

Other components of an extended or custom 5000 system will have power requirements, fusing or breakers, and voltage information contained in the CD package.

Do not alter these factory set configurations. Only qualified service personnel may access these settings for modification or inspection. The power requirements labeling on the exterior of a system component must be clearly re-marked to indicate any new AC source information. If qualified personnel are not available to perform these tasks, contact AMETEK service.

Physical wire types for power and interconnects should be an agency-approved type (UL/CSA/Harmonized, etc.) for the region of installation. The CD package contains suggestions for wire gauges and/or information on current/power requirements in the case of power cable.

Explosion Hazard Warning

- If the 5000 controller is located in a Class I, Division 2 area, you must shut down the power source before service or maintenance. Never disconnect power at the analyzer until you are sure that the area is known to be nonhazardous.
- Do not substitute parts as this may impair the analyzer's suitability for Class I, Division 2 use.
- If a specific procedure requires the unit to be energized, a hot work permit may be required; check with your safety consultant.
- Power, input and output wiring (I/O) must be in accordance with Class I, Division 2 wiring methods [Article 501-4 (b) of the National Electrical Code, NFPA 70] and in accordance with the authority having jurisdiction.

Installation Requirements

These components are meant to be permanently connected devices. Qualified installation personnel must adhere to the nationally recognized standards for power cable type and building breaker or fusing for use with this type of equipment. These must be in compliance with the power requirements stated in the CD package and for use in the intended environment (general purpose or hazardous).

This equipment is designed to operate from local branch circuits (Installation Category II).

In addition to these requirements, the power connections must have the following characteristics:

- It must include a separate disconnect device, such as a switch or circuit breaker, included as part of the building installation. The electrical specifications of this device must accommodate the power and environmental requirements of the equipment for the particular application.
- This device must be in proximity to the equipment and within easy reach of an operator.
- This device must be permanently marked as the disconnect device for the equipment.

Hazardous Installation Requirements

Zone 1

For Zone 1 sample system installations, no cable glands or strain reliefs are supplied with the system. Only removable gland plates and junction boxes with threaded entries are provided. It is the customer's responsibility to provide for the complete installation of this system. (Refer to Chapter 2 and CD package.) This includes supplying and installing external fittings, cabling, strain reliefs, suitable cable glands, etc. Only qualified personnel should perform this installation with adherence to all the additional electrical and mechanical requirements for this type of installation and location.

NEC Division 1 and 2

For NEC Division 1 and 2 sample system installations, the internal sealoffs or fittings are supplied in the system, but must be sealed by the customer before being put into service. All other external fittings, cabling, conduit, etc. are the responsibility of the customer. (Refer to Chapter 2 and CD package.) Only qualified personnel should perform this installation with adherence to all the additional electrical and mechanical NEC requirements for the installation type and location.

Installation Procedure

This procedure makes the following assumptions:

- The shielded interconnecting cable between the field unit and controller is already in place with wires clearly identified at both ends
- An AC power source of adequate current rating is available at both locations.

1. Unscrew and remove the lid from 5000 Field Unit.
2. Connect controller signal and alarm outputs to user recording equipment as shown in the CD package.
3. Connect AC power source to:

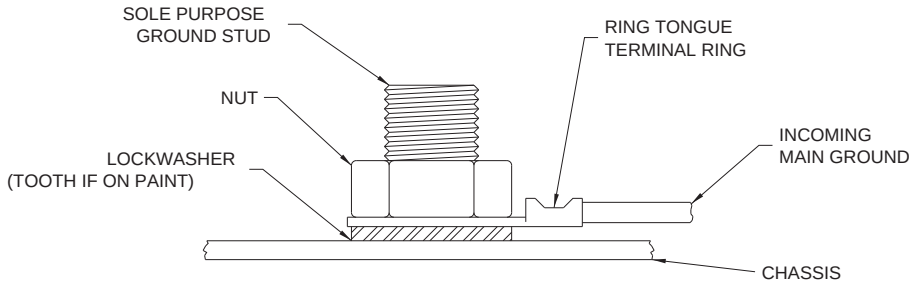
   Field Unit — TB1-1 AC line, TB1-2 AC Neutral, and GND to TB1-3 or to chassis ground stud.

   Controller—TB5-1 AC line, TB5-2 AC NEUT, and GND lug. TB5-3 can be used to jumper line voltage to Sample and Alarm Common.

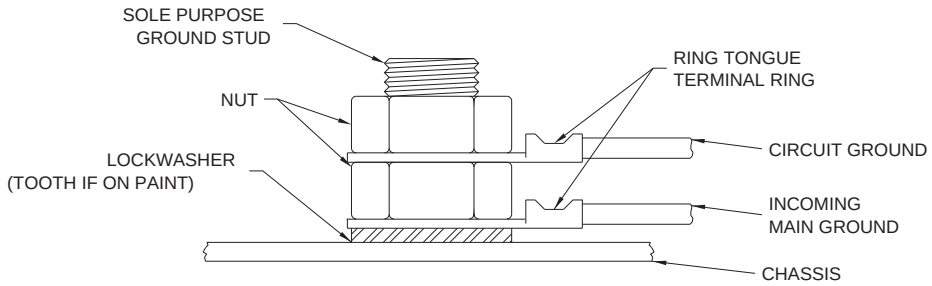
4. Instrument grounding is mandatory. Performance specifications and safety features are void if the unit is operated from an improperly grounded source. Check ground integrity to all portions of the analyzer before power up. See Fig. 3-3 for proper internal grounding instructions.

WARNING

Do not power up AC source(s) at this time.

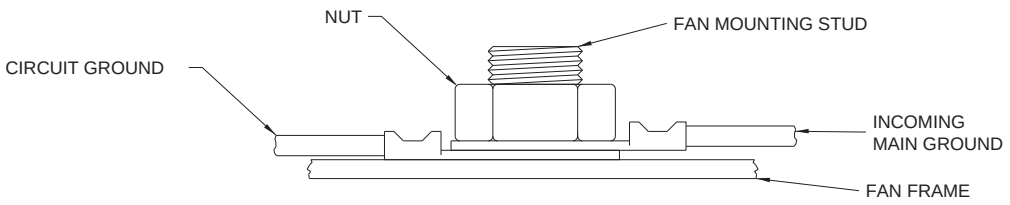


Proper Single Ground Screw



Circuit ground can be removed for servicing independently of incoimg main ground. No lockwasher. Stud not sole purpose.

Proper Multiple Ground on Single Screw



Circuit ground cannot be removed for servicing fan without disturbing incoimg main ground. No lockwasher. Stud not sole purpose.

Improper Multiple Ground on Single Screw

Figure 3-3.
Proper and improper protective ground connections.

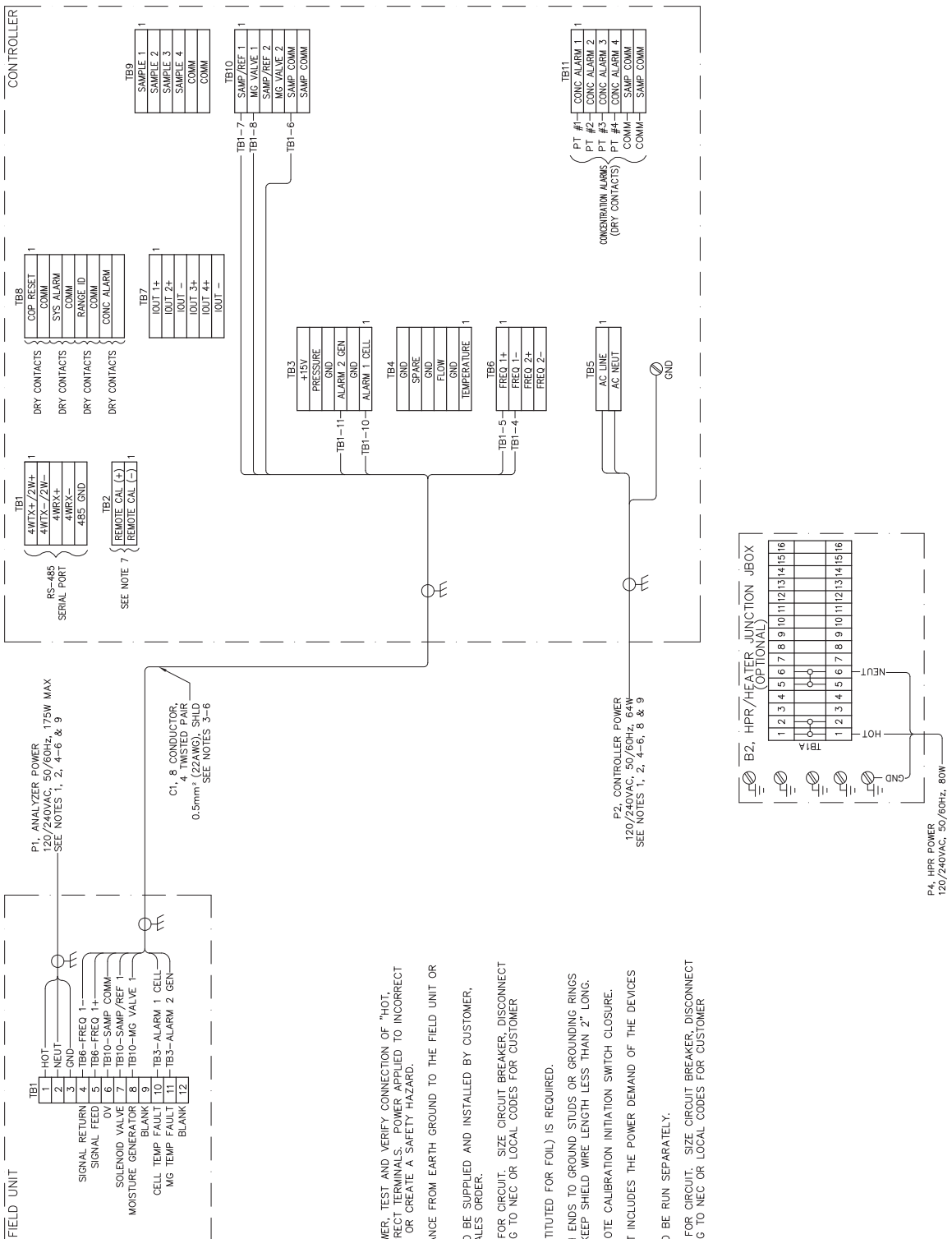


Figure 3-4.
Interconnecting wiring diagram for 5000 field unit and 5000 controller.

NOTES:

1. WARNING: BEFORE APPLYING POWER, TEST AND VERIFY CONNECTION OF "HOT, NEUTRAL & GROUND" WIRES TO CORRECT TERMINALS. POWER APPLIED TO INCORRECT TERMINALS CAN DAMAGE EQUIPMENT OR CREATE A SAFETY HAZARD.
2. THE MAXIMUM PERMITTED RESISTANCE FROM EARTH GROUND TO THE FIELD UNIT OR CONTROLLER IS 20 OHMS.
3. INTERCONNECTING CABLES ARE TO BE SUPPLIED AND INSTALLED BY CUSTOMER, UNLESS OTHERWISE SPECIFIED ON SALES ORDER.
4. POWER STATED IS ACTUAL LOAD FOR CIRCUIT. SIZE CIRCUIT BREAKER, DISCONNECT SWITCH, AND WIRE GAUGE ACCORDING TO NEC OR LOCAL CODES FOR CUSTOMER SPECIFIC INSTALLATION.
5. 100% FOIL (ARMOR CAN BE SUBSTITUTED FOR FOIL) IS REQUIRED.
6. GROUND CABLE SHIELDS AT BOTH ENDS TO GROUND STUDS OR GROUNDING RINGS (AS SHOWN ON DRAWING 520403). KEEP SHIELD WIRE LENGTH LESS THAN 2" LONG.
7. CONNECTIONS FOR OPTIONAL REMOTE CALIBRATION INITIATION SWITCH CLOSURE.
8. CONTROLLER POWER REQUIREMENT INCLUDES THE POWER DEMAND OF THE DEVICES CONNECTED TO TB9.
9. POWER & SIGNAL CABLES SHOULD BE RUN SEPARATELY.
10. POWER STATED IS ACTUAL LOAD FOR CIRCUIT. SIZE CIRCUIT BREAKER, DISCONNECT SWITCH, AND WIRE GAUGE ACCORDING TO NEC OR LOCAL CODES FOR CUSTOMER SPECIFIC INSTALLATION.

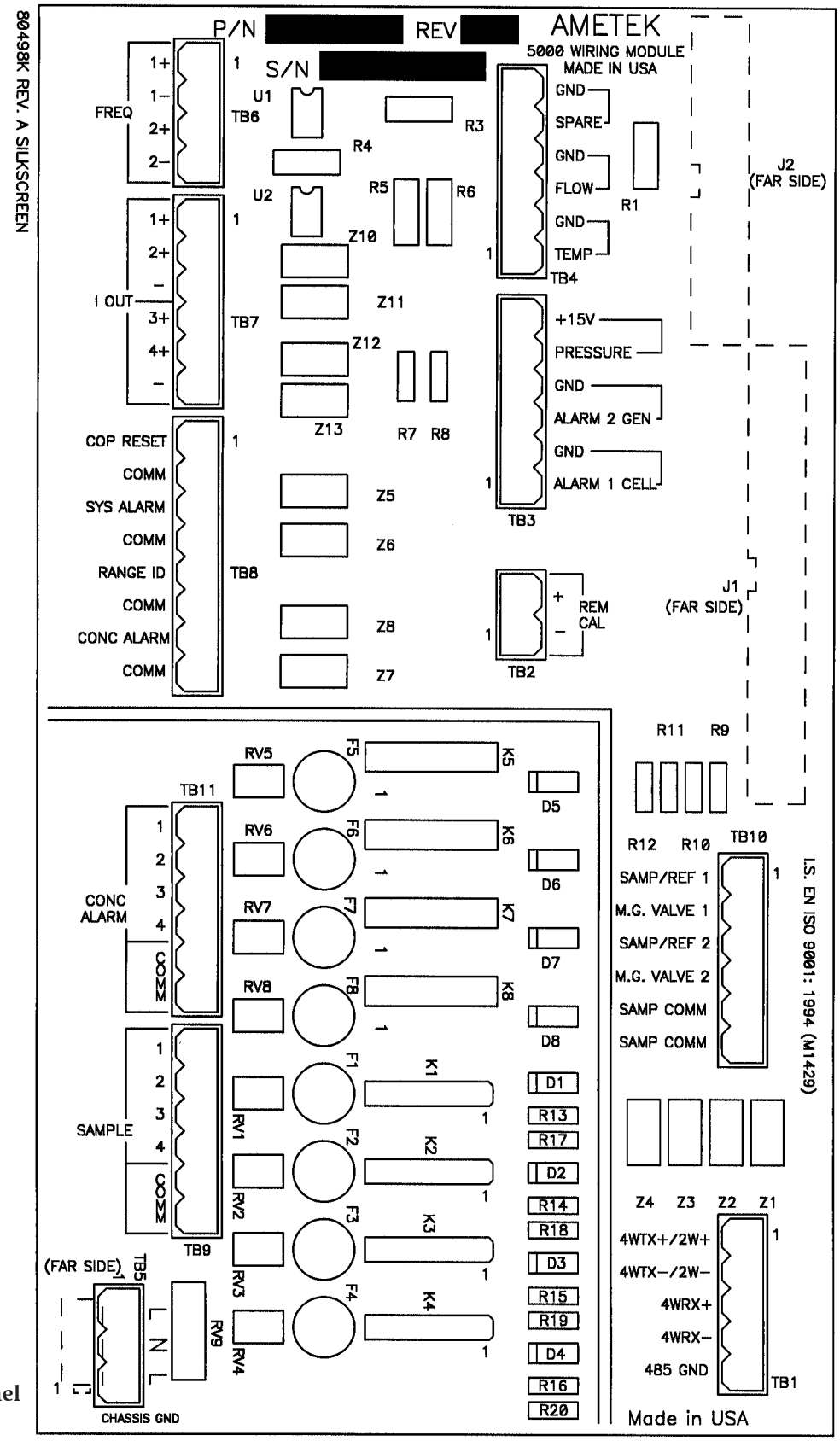


Figure 3-5. Model 5000 controller back panel connections.

Sample Tap

To ensure the sample is free of contaminants from the walls of the sample pipeline, we recommend a probe extending into the pipe. The probe tip should be cut to a 45° angle and located about 20-30% into the pipe ID. Mount the probe through a ball valve (shut-off valve) on a horizontal section of the pipe as shown in Figure 3-6.

CAUTION

The sample gas, or gases to be monitored by the analyzer may be toxic, corrosive, and / or flammable. AMETEK strongly recommends that trained service personnel use proper protective equipment including air breathing apparatus, eye protection, and skin protection whenever the gas line(s) or Field Unit are accessed for installation or maintenance.

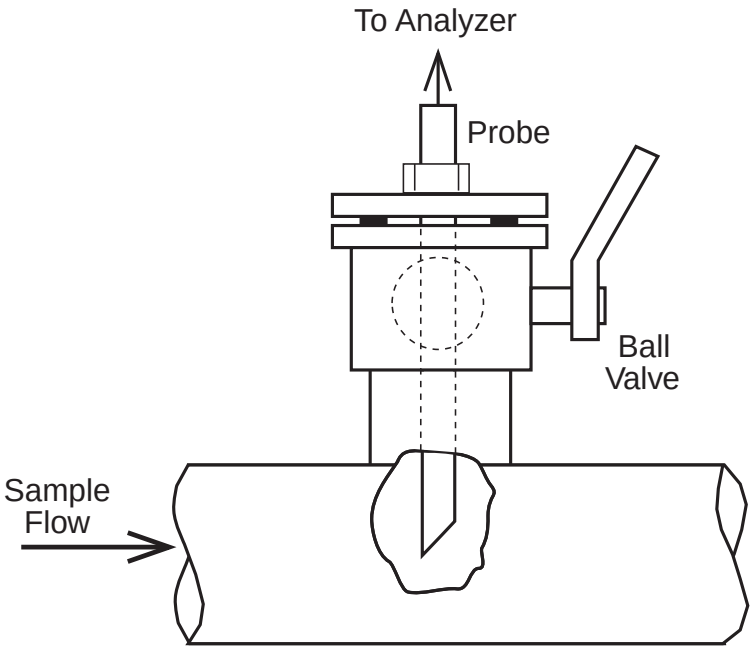


Figure 3-6. Typical probe installation.

Sample Pressure, Temperature, and Flow Rate

A pressure reducer/regulator should be installed near the sample tap. Variations in flow of 10 percent will not affect instrument accuracy. Nominal sample pressure to the system should be 520 kPa (75 PSI) gauge with a minimum pressure of 200 kPa (30 PSI) gauge. Temperature of the incoming sample gas should not exceed the analyzer cell temperature of 60 °C (140 °F). Sample, reference, and moisture generator flow rates through the cell are set to 250 cc/min (at 2 atm) at the field unit. A bypass flow valve located near the analyzer will improve analyzer response time.

Sample Lines & Connections

Cleaned and passivated 316L stainless steel* with 0.125 to 0.25 in. OD sample line tubing is recommended for use throughout the sample system. Note that ordinary stainless steel tubing can have an internal finish that may cause moisture holdup and slow analyzer response. Exhaust vent tubing should have an OD of 0.25 inch or greater to prevent back pressure from affecting the flow rate to the measuring cell.

To avoid sample contamination, the sample stream should not come in contact with plastic, rubber, oil, grease, or dirt. Use Teflon® fluorocarbon resin tape or Loctite® 545 on all threaded (not compression) connections. Check all sample line connections with a bubble-type leak detector.

Low temperature and/or high pressure can cause moisture to condense on the sample line walls. Water (or other liquids) in the sample line can migrate to the analyzer cell causing the crystal to stop oscillating. This will result in erratic moisture concentration data until the liquid evaporates and the crystal returns to normal operation state. If this happens, the calibration of the instrument will no longer be valid. Full calibration and span adjustment will be necessary.

Water migration to the analyzer cell will destroy the hygroscopic crystal coating. If analyzer function does not return to normal, the cell must be replaced.

Sample Conditioning

Conditioned sample gas is normally used as the reference gas for moisture analysis. Instrument air or nitrogen may be used if the sample has a high level of particulate or if sample flow rate is too low. Whether from the sample or a separate source, the reference gas passes through a standard

** PN 571061017 - stainless steel tubing, 0.125 in. OD x 10 ft.*

dryer containing a 3A molecular sieve and an in-line filter (both included) before entering the field unit. Note that the use of a reference gas different from the sample gas can cause background interference. Refer to Appendix C for data correction procedure.

For some special applications, we recommend that the sample should also be run through a contaminant trap and a super-activated dryer. Refer to the supplemental information supplied with the system to determine if these optional components are to be used.

NOTE

Moisture contamination of the dryer(s) can cause incorrect sample moisture data. To prevent this contamination, never leave either end of a dryer open and exposed to atmospheric moisture.

Conditioned sample gas used as reference

Configure sample system as shown in Figure 3-7a. Standard and optional conditioning components (dryers, contaminant traps) should be strapped in the **upright position** to support beams.

NOTE

Dryer(s) must be vertical to avoid channeling (voids in the sieve).

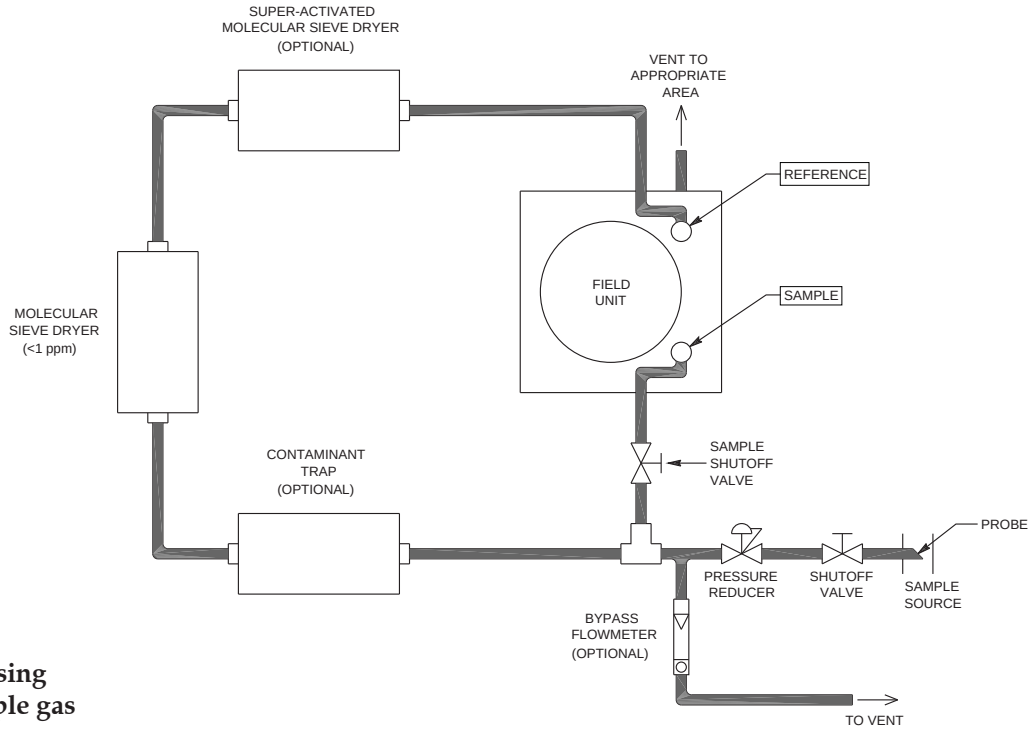


Figure 3-7a.
Sample system using conditioned sample gas as reference.

Separate Gas Source Used As Reference

Configure sample system as shown in Figure 3-7b. Standard and optional conditioning components (dryers, contaminant traps) should be strapped in the **upright position** to support beams.

NOTE

Dryer(s) must be vertical to avoid channeling (voids in the sieve).

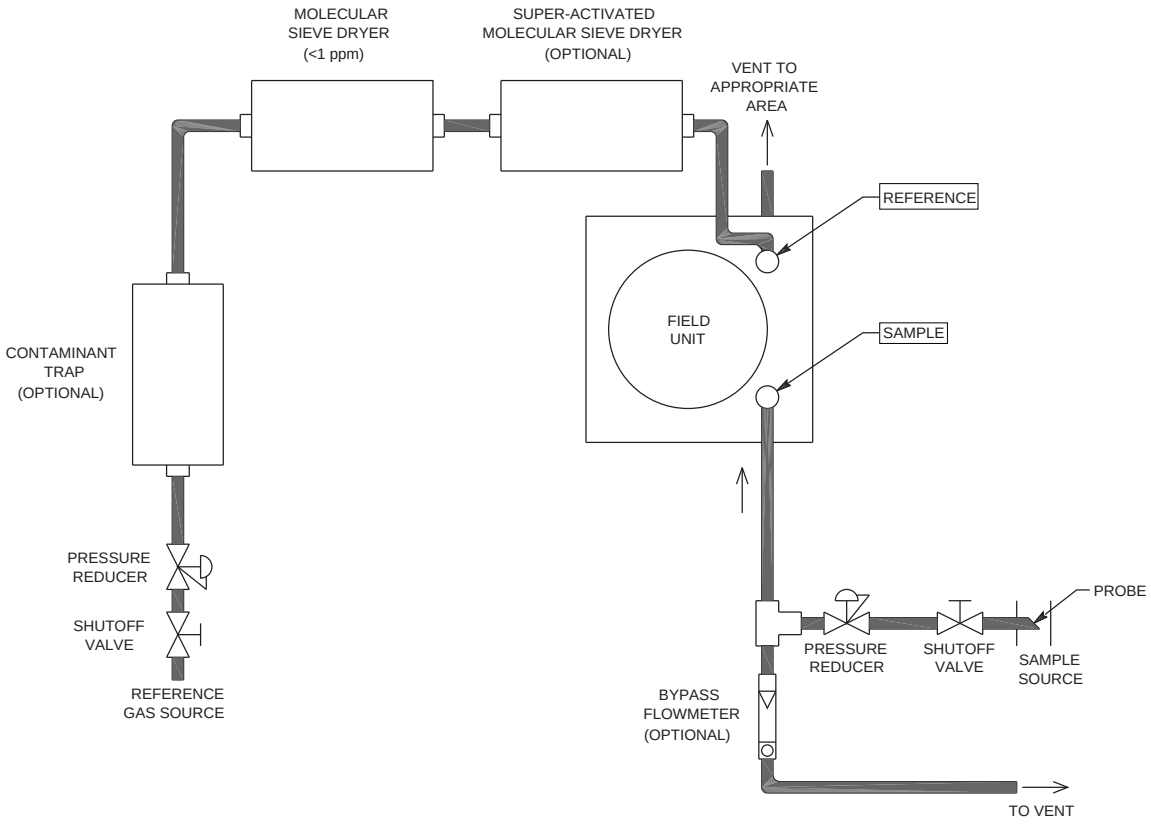


Figure 3-7b.
Sample system using separate gas source as reference

NOTE

A separate source (if present) should also be run through an oil/air separator to remove trace quantities of oil from the gas. Oil in the reference stream will cause rapid contamination of the analyzer cell.

Gas Connections to Analyzer

Proper sample line purge must be performed before connecting the sample line to analyzer. Condensate in the sample line can migrate to the cell which may result in irreparable damage to the crystal oscillator.

1. Open the main process sample line valve and pressure reducer carefully. Vent the line to an appropriate area and purge it with clean, dry instrument air or nitrogen.
2. Close the process sample line valve and pressure reducer and connect the sample line to the $^1/_8$ inch sample inlet fitting.
3. Connect the conditioned reference gas line (from either the sample or a separate source) to the $^1/_8$ inch reference inlet fitting.
4. Connect vent line to analyzer $^1/_4$ inch exhaust port fitting.
5. Vent the line to appropriate area.

Consult plant safety personnel for appropriate venting guidelines.

USER INTERFACE

Controller Display

The 5000 Controller default normal operation screen is shown in Figure 4-1. The first three lines of the display are fully user-programmable. Live moisture concentration and system values such as cell temperature, pressure, and flow rate can be displayed. The fourth line displays system messages and alarm / error information only. Refer to **Display Flags** and **Labels** in Chapter 5 for more information on changing the format of the controller display.

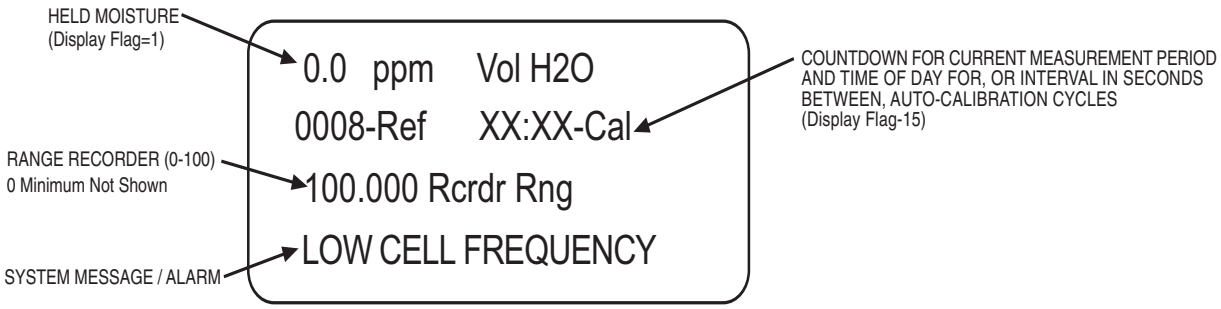


Figure 4-1.
Typical operation screen (system message will vary)

System Security and Passwords

The 5000 Controller has four system security levels: Levels 0, 1, 2 and Level 3. You must enter a password before you can access certain menus and system values. Factory default passwords are listed later in this section.

Higher levels passwords can access any lower level function.

With the exception of Level 3 security, default passwords can be altered or eliminated by changing the software configuration. Refer to Chapter 5 for more information on altering system security.

Level 0 Security (Operator Level)

No password is required for the following functions:

- Initiate an auto-calibration cycle with **no** span adjustment.
- View upper and lower levels for concentration alarm.
- View upper and lower range limits for 4 to 20 mA analog outputs 1 and 2.
- Manually select high or low range setting for analog output 1.

Level 1 Security (Maintenance Level)

The Level 1 password is required for the following functions:

- Initiate an auto-calibration cycle with auto-span adjustment.
- Alter upper and lower levels for concentration alarm.
- Alter upper and lower range limits for 4 to 20 mA analog outputs 1 and 2.
- Access the Config/Test main menu and:
  - View all software configuration values.
  - Set time of day and time for auto-cal cycle if it is to be run at 24-hour intervals.
  - Run system self-tests for troubleshooting purposes.

Level 2 Security (Configure Level)

The Level 2 password is required to access the Level 2 Configure Menu and perform the following functions:

- Alter system constants including pressure and temperature constants.
- Select flags to change the system parameters linked to the analog outputs, concentration alarms, and first three display lines.
- View and alter period timers including calibration cycle timers.
- Select configuration flags from the **Flags1** list in Chapter 5.
- Invoke noise suppression for frequency, pressure, temperature, and flow data.
- Change security passwords for Levels 1 and 2.

Level 3 Security (Service Level)

The Level 3 password, which cannot be disabled or changed, is required to access the Level 3 Configure Menu and perform the following functions:

- Alter polynomial coefficients used in the moisture concentration calculations.
- Alter system values including cell span and temperature constants.
- Alter text of first three display lines.
- Select configuration flags from the **Flags2** list in Chapter 5.
- Alter f_{sample} and $f_{\text{reference}}$ analysis periods.
- Reset all system values to factory default settings.

Function Key Overview

All analyzer functions are configured using the 5000 Controller keypad shown in Figure 4-2. Press one of the four function keys (CALIB, ALARM, ANALOG RANGE, and TEST/CONFIG) to access the main menu for that category's sub-menus and system values. Use the arrow keys (2,4,6,8) to scroll up, down, left, and right through menu items and system value lists. Enter values (which may be negative or contain a decimal point) using the number keys (0 through 9) and the – and • keys.

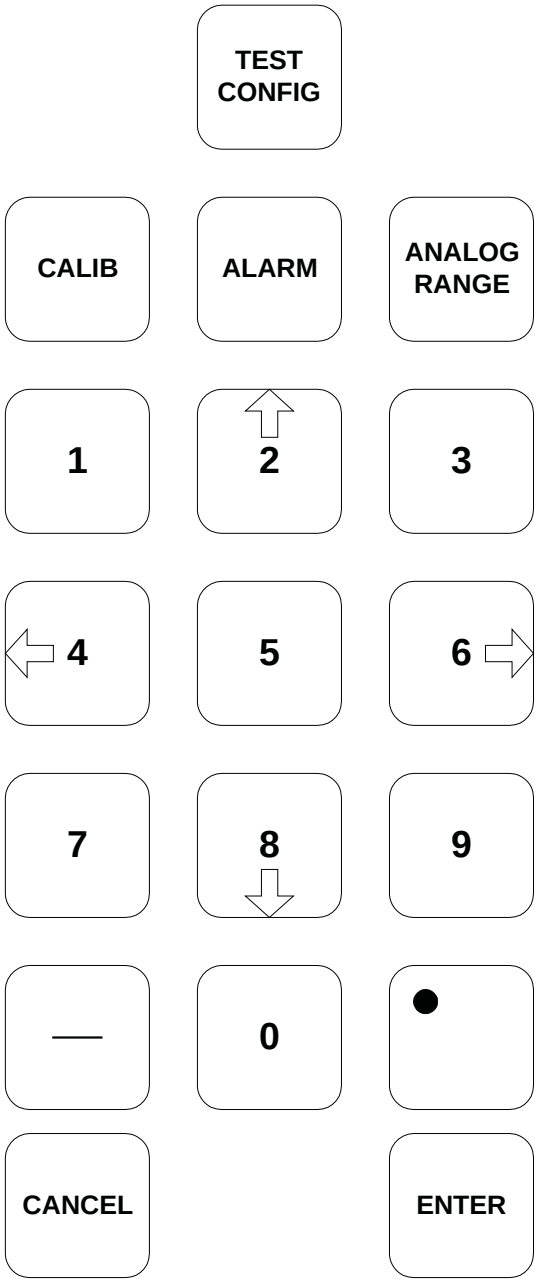


Figure 4-2.
5000 controller keypad.

Selecting an Item

Scroll through the menu items until the small arrowheads point to the item you want to select. If there are additional menu items above or below the currently displayed item, you will see up and down arrow keys on the right-hand side of the screen (Figure 4-3) .

Once you access a menu, use the arrow keys to scroll through the menu until the desired item is selected. Press **Enter** to select the menu item. Depending on the selected menu item, more menus can be displayed or data entered. Follow the instructions shown on the display. Except where otherwise noted, press **Enter** to save changes and return to the previous menu or press **Cancel** to quit without saving. Pressing **Cancel** also exits to previous menu levels, backing out one level at a time, until the display shows the normal operation screen.

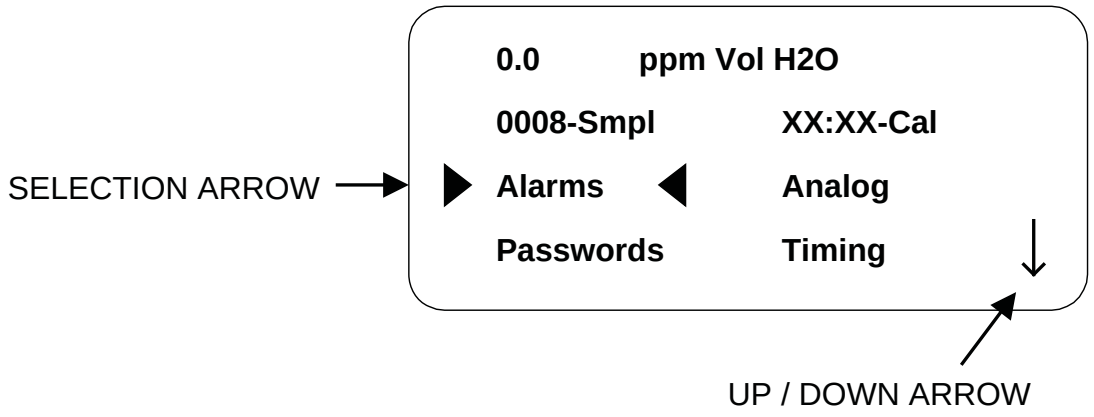


Figure 4-3.
5000 controller display.

Field Unit Controls & Indicators

Numbers in parentheses in the text of this section correspond to the numbers shown on the 5000 Field Unit controls and ithe ndicators shown in Figures 4-4 and 4-5.

Find Number	Description	Normal Position	Function
CR11	Red LED	On/Off	Indicates samle gas is flowing through cell.
CR10	Red LED	On/Off	Indicates reference gas is flowing through cell.
CR1	Red LED	Blinking	Indicates cell oven heater duty cycle.
CR7	Red LED	Off	Indicates analyzer is in generator mode.
CR14	Red LED	Blinking	Indicates moisture generator heater duty cycle.
1	Sample gas flow control	As Required	Adjusts sample gas flow.
2	Reference gas flow control	As Required	Adjusts reference gas flow.
3	Moisture generator flow control	As Required	Adjusts reference gas flow.
4	Back pressure regulator control	As Required	Adjusts back pressure for all gases.
5	Flowmeter	As Calibrated	Reads gas flow rate through cell.
6	Back Pressure gauge	103 kPa gauge (15 PSIG)	Indicates gas back pressure.
S1	Moisture generator flow disable	Open (Press and hold to activate)	Disable moisture generator flow. Sample gas will flow instead to aid in sample gas flow rate adjustment.

Figure 4-4.
5000 Field Unit controls and indicators.

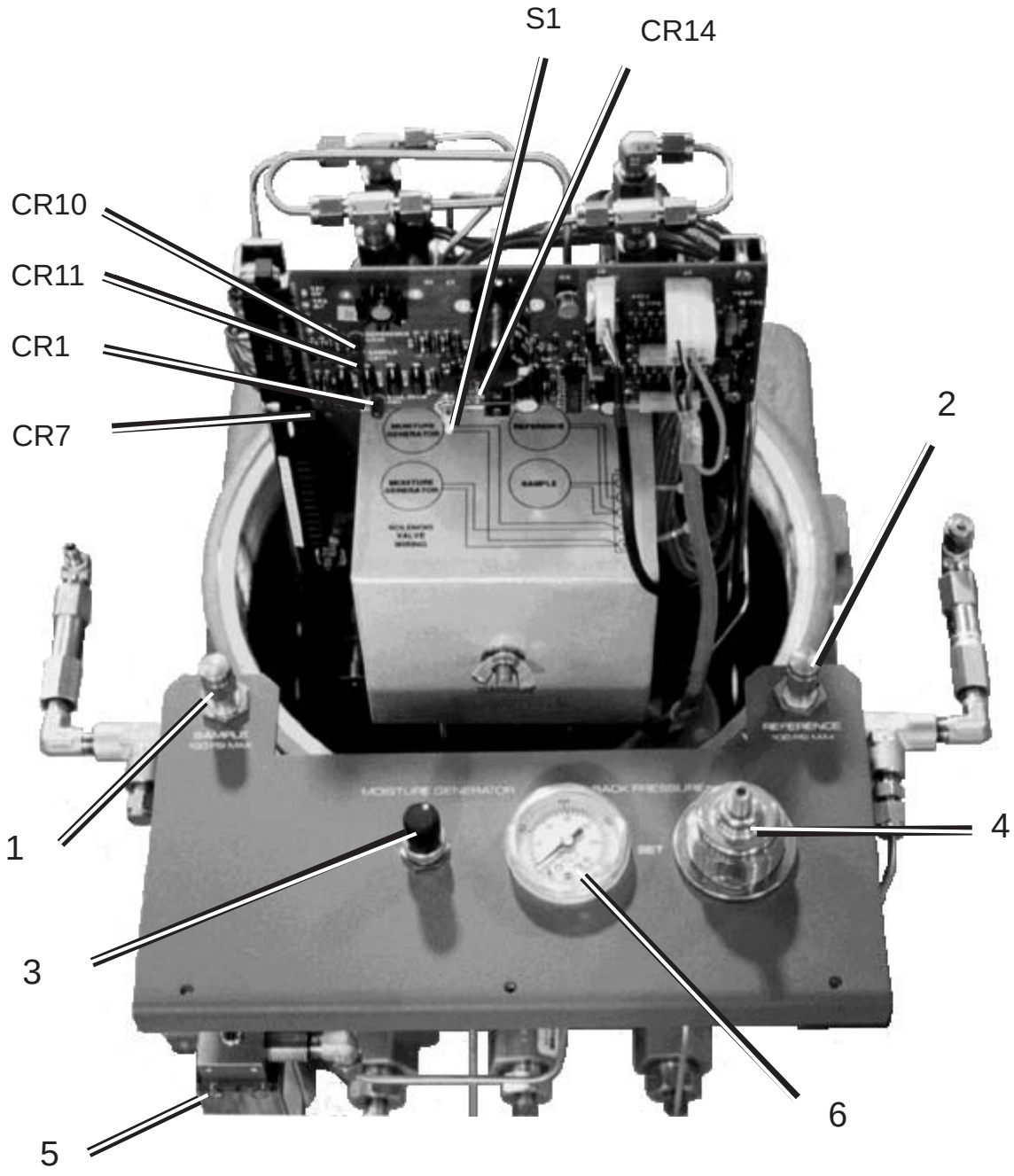


Figure 4-5.
5000 Field Unit controls and indicators.

Initial Flow Rate and Back Pressure Adjustments

CAUTION

Do not cap off or block the exhaust line. Doing this will apply full line pressure across the back pressure gauge and may permanently damage the gauge and possibly the field unit. Ensure that the analyzer exhaust is vented appropriately.

1. Apply power to the controller and field unit. Boot-up information is displayed momentarily and then the default normal operation screen (Figure 4-1) displays.

2. Turn the adjusting screw (4) counterclockwise to fully open the back pressure regulator control. This ensures that there will be no pressure in the field unit when you first apply the sample gas. Make note of the pressure on the back pressure gauge (6).

3. Check to make sure the main process sample line pressure reducer is closed and then open the main process sample line shutoff valve.

   Adjust the pressure reducer to a nominal 520 kPa (75 PSI) gauge.

NOTE

Minimum pressure to the field unit is 200 kPa gauge (30 PSIG) and maximum is 670 kPa gauge (100 PSIG).

   If a separate reference gas is used, open the reference source and set the pressure to the same value as the sample.

4. Slowly open the reference gas flow control valve (2) and adjust flow to midscale on the flowmeter (5).

NOTE

*The flowmeter will read flow only every other cycle. This is because the flowmeter reads flow **through the cell** and there is no flow for half the cycle at this time.*

   The bottom line of the controller display will read "Reference Flowing."

5. When the sample cycle begins and the display reads "Sample Flowing," slowly adjust the sample gas flow valve (1) for midscale on the flowmeter (5).

NOTE

With the sample gas flowing, the back pressure should remain the same as the value noted in Step 2.

Adjust back pressure if necessary.

6. Press the **Calib** key on the controller and then press the **Down Arrow** key to select "Flow Moisture Gen."

   Press **Enter** and, when prompted, enter the password to begin the calibration (reference/moisture generator) cycle.

   Adjust the moisture generator flow control (3) for midscale on the flowmeter (5). Flow does not have to be set accurately at this time, but sample, reference, and moisture generator gases must all be flowing.


NOTE

With moisture generator gas flowing, the back pressure should remain the same as the value noted in Step 2 above.

   Press **Cancel** to end moisture generator flow and return to normal (reference/sample) operation.

7. Run another cycle of normal operation and verify that the indicated flow rate and back pressure remain constant.

   Repeat Step 6 to verify that flow rate and back pressure do not change when moisture generator gas is flowing.

   Adjust the back pressure (4) and flow rates (1,2,3) until they are stable regardless of which gas is flowing.

8. Operate the system under those conditions for dry-down. Continue until cell frequency is within ~200Hz of the dry cell frequency. The dry cell frequency is variable #46 on the configuration sheet. To monitor cell frequency, program one of the display flags to 03. Refer to Chapter 5, Display Flags.


NOTE

Allow the system at least 24 hours to dry-down on dry gas. Depending on the process and the sample system configuration, dry-down may take longer.

Flow Rate and Back Pressure Fine Adjustment


NOTE

If a separate reference gas is used, this flow adjustment must be done on both gases, one at a time.

Line voltage up to 253V may be present in the field unit.

1. Ensure that there is sufficient pressure to maintain 30 PSIG on analyzer input.

2. Adjust the back pressure regulator (4) and flow controls (1, 2, 3) until the pressure gauge (6) reads the equivalent of 103 kPa gauge (15 PSIG) regardless of which gas is flowing.

   Back pressure values are referenced to standard atmospheric pressure. The correct pressure gauge setting depends on the average barometric pressure at your specific system location. To determine the proper gauge setting, use the following calculations.

Gauge setting in kPa: = 103 + [100 – (average barometric pressure in kPa)]

Example:
Average barometric pressure at installation site is 90 kPa. The proper gauge setting is:

$$103 + [100 – (90)] = 103 + 10 = \mathbf{113\ kPa}$$

Gauge setting in PSIG= 15 + [14.7 – (average barometric pressure in PSIA)]

Example:
Average barometric pressure at installation site is 13 PSIA. The proper gauge setting is:

$$15 + [14.7 – (13)] = 15 + 1.7 = \mathbf{16.7\ PSIG}$$

3. Close the sample and reference flow control valves. Do not overtighten the valves. Allow the moisture generator flow valve to remain open. This flow is the most critical and will be set using a Bubble-O-Meter® (PN 303030003) or a similar flow measuring device.

4. Disconnect the moisture generator valve switching wire from field unit TB1-8.

5. Connect the Bubble-O-Meter or other flow measuring device to the 1/4-inch back pressure regulator fitting. Refer to Appendix B for proper usage of a Bubble-O-Meter.

6. If using a Bubble-O-Meter, the transit time required for 500 mL of gas at ambient pressure and gas temperature must be normalized to the

transit time for 500 mL at pressure ~760 mm Hg and gas temperature ~27 °C. Use the following equation and the data found in Figure 4-6 to determine the transit time at the ambient pressure and temperature. Note that this calculation may not be necessary if another flow measuring device is used.

where: P_1 = ambient pressure (mm Hg)
P_2 = water vapor pressure from Figure 4-6
T_{gas} = gas temperature inside Bubble-O-Meter

7. Adjust the moisture generator flow control (3) until the soap bubble requires the calculated transit time to travel 500 mL. (Since the flowmeter is calibrated for air @ STP the reading on the flowmeter will not indicate 500 ml/min). Refer to Fig 4-6.

$$\text{Transit Time (sec)} = (60)\left(\frac{P1 - P2}{760}\right)\left(\frac{298}{273 + T_{gas}}\right)$$

8. Since moisture generator flow and back pressure interact with each other, recheck them now .

9. Using a marking pen, mark the flowmeter at the ball position to indicate the desired flow. Disconnect the flow measuring device.

   Press and hold the reset field unit switch (S1) and adjust the sample flow control valve to the flowmeter mark.

10. If necessary, readjust the back pressure regulator (4).

11. Reconnect the TB1-8 wire and normal system operation will begin.

12. When the reference gas cycles on, adjust the reference flow control (2) to the flowmeter mark, and the back pressure to 103 kPa gauge (15 PSIG).

13. Re-install the lid on the field unit.

Cell Verification and Span Adjustment

Cell verification isachieved by measuring the moisture content of the reference gas after a known quantity of moisture has been added by the moisture generator. The measured value is then compared to the value stored in the computer memory. Refer to the Configuration Data Sheet supplied with the controller for the verification moisture concentration specific to the analyzer (Moist_Gen).

Bubble-O-Meter Pressure Temperature Chart

Tgas (°C)	P2 (mm Hg)	Tgas (°C)	P2 (mm Hg)	Tgas (°C)	P2 (mm Hg)	Tgas (°C)	P2 (mm Hg)
–15	1.4	2	5.3	19	16.5	36	44.6
–14	1.6	3	5.7	20	17.5	37	47.1
–13	1.7	4	6.1	21	18.6	38	49.7
–12	1.8	5	6.5	22	19.8	39	52.4
–11	2.0	6	7.0	23	21.1	40	55.3
–10	2.1	7	7.5	24	22.4	41	58.3
–9	2.3	8	8.0	25	23.8	42	61.5
–8	2.5	9	8.6	26	25.2	43	64.8
–7	2.7	10	9.2	27	26.7	44	68.3
–6	2.9	11	9.8	28	28.3	45	71.9
–5	3.1	12	10.5	29	30.0	46	75.7
–4	3.4	13	11.2	30	31.8	47	79.6
–3	3.7	14	12.0	31	33.7	48	83.7
–2	4.0	15	12.8	32	35.7	49	88.2
–1	4.3	16	13.6	33	37.7	50	92.5
0	4.6	17	14.5	34	39.9		
1	4.9	18	15.5	35	42.2		

Figure 4-6.
Bubble-O-Meter chart.

The Verification/Span Adjustment function can be run on demand (see Flow Moisture Gen) or configured to run automatically at a user-set interval. The calibration cycle includes equilibration (stabilization) time for the moisture generator gas flowing through the cell, cell frequency measurements (f_{cal} and f_{ref}), automatic span adjustment (optional), and return to normal operation.

Calib Key

With the normal operation screen displayed, press the **Calib** key to call up the menu. Use the **Up** and **Down Arrow** keys to scroll through the menu items. Press **Enter** once you have selected the desired menu item and proceed as follows:

Start Auto Cal

Initiates automatic calibration cycle with or without span adjustment. At the "Engage Auto Span?" prompt:

- Press **Enter** and use maintenance level password to run cal cycle with span adjustment, or

- Press **Cancel** to run cal cycle only.

The display returns to normal operation screen when the cycle is complete. If the calibration cycle includes a span calculation and adjustment, the new span value will be checked against the **Max_Cal_Err** and **Max_Span** setpoints (see **Alarm Button** later in this chapter). If the new value exceeds the setpoint, a system alarm will occur and **CAL ERROR** will appear on the bottom line of the display (in the case of error, span adjustment will not take place).


NOTE

Both tests can be disabled by making the setpoints equal to zero.

Flow Moisture Gen

Initiates a completely manual calibration cycle with span adjustment. The display will read,

"Wait for instrument to stabilize, then Enter = Span, Cancel = Quit."


NOTE

The manual cycle does not invoke system timers. You must allow time for equilibration before and after the cal cycle.

After equilibration, press **Enter** to proceed with cal and span adjustment or press **Cancel** to return to normal operation.

Alarms and Alerts

There are three alarm contacts supplied through relays on the CPU board. The default on all alarms is fail-safe (normally closed). Alarms can also be set for normally open operation.

Computer Operating Properly (Watchdog) Alarm

In addition to the three contact alarms, the Computer Operating Properly (COP) or watchdog alarm activates when normal CPU logic flow is disrupted. Activation of this alarm indicates loss of power, internal hardware failure, software problems, or extreme electronic interference. The COP alarm automatically generates a system reset but does not return the analyzer to factory-default software configuration.

Analog Range Alarm

Analog Range alarm contacts are activated when the Channel 1 analog output (4–20 mA) is operating in the higher of its two output ranges. The signal can be used to alert the user recording equipment that the Channel 1 range has changed. Refer to Analog Ranges for more detailed information on analog output ranges.

The Range Alarm can also be configured to alert user recording equipment that the analog outputs represent calibration data during cal cycle.

Concentration Alarms

Two High Concentration alarm contacts are activated when either one of two system values exceed the setpoint (upper or lower) for various analyzer parameters. The normal parameter which triggers this alarm is moisture level, however these alarms can be configured to activate when other parameters (temperature, pressure, cell frequency, etc.) exceed the setpoints. Refer to Chapter 5, Alarm Flags for more information on linking parameters to alarm contacts.

One Concentration Alarm can be configured to provide a confirmation of the validity of other analyzer outputs.

Alarm Key

With the normal operation screen displayed, press the **Alarm** key to call up the menu. Use **Up** and **Down Arrow** keys to scroll through the menu items. Press **Enter** once you have selected the desired item menu and proceed as follows:

View Alarm Levels

View upper and lower setpoints for both concentration alarms. Use **Up** and **Down Arrow** keys to select the setpoint to view. Press **Enter** to display current value. Press **Cancel** to return to the Alarm menu.

Alter Alarm Levels

Alter upper and lower setpoints for both concentration alarms. If maintenance level security is in effect, you must enter the maintenance password to continue. Use **Up** and **Down Arrow** keys to select the setpoint to alter. Press **Enter** to display the current value. Use the **Number** keys to enter the new value. Press **Enter** to save the change and return to the Alarm menu. Note that the units associated with these values correspond to the data on the signal. Refer to Chapter 5, Alarm Flags for the various flags and associated units.

Analog Ranges

Each analyzer has two fully configurable 4 to 20 mA analog output channels. Channel 2 output has one sensitivity range and Channel 1 output has both high and low ranges. You can adjust the upper and lower range limits on all outputs for the desired resolution. Refer to Chapter 5, Analog Flags for information on configuring the analog outputs to track system values such as moisture concentration, flow rate, and pressure.

High Concentration alarm will be activated if system value exceeds setpoint.	Alarm_1_Hi	The upper limit of concentration alarm 1.
	Alarm_2_Hi	The upper limit of concentration alarm 2.
	Alarm_1_Low	The lower limit of concentration alarm 1.
	Alarm_2_Low	The lower limit of concentration alarm 2.
System alarm (CAL or ZERO ERROR) will be activated if system value exceeds setpoint.	Max_Cal_Err	Maximum Δ between indicated and stored values.
	Max_Span	Maximum allowable cell span.
	Max_CD	Maximum allowable coefficient D.

Figure 4-7.
Setpoints to be viewed or altered for Alarm key.

The output range on Channel 1 can be toggled between low and high manually or automatically. The auto-range function switches Channel 1 from low to high range when the signal is close to the upper limit of the low range (~97%). Auto-range also switches Channel 1 from high to low range when the signal reaches ~85% of the upper limit of the low range.

Analog Range Key

With normal operation screen displayed, press the **Analog Range** key to call up the menu. Use **Up** and **Down Arrow** keys to scroll through the menu items. After highlighting the desired item, press **Enter** and proceed as follows:

Range Select-Out1

View and/or alter current analog range (high or low) on output channel 1.

- Press **Cancel** to return to Analog Range menu without changing the range.

- Press **Enter** to toggle between low and high range; press **Cancel** to accept the displayed range and return to normal operation screen.

View Range Limits

View upper (output) and lower (offset) setpoints for both high and low output ranges on Channel 1 and Channel 2 output range. Use **Up** and **Down Arrow** keys to highlight setpoint to view. Press **Enter** to display current value.

Alter Range Limits

Alter upper (output) and lower (offset) setpoints for both high and low ranges on Channel 1, and Channel 2 analog outputs. Use **Up** and **Down Arrow** keys to highlight setpoint to alter; press **Enter** to display current value. Use **Number** keys to enter the new value. Press **Enter** to load the change and return to the Analog Range menu. Note that the units associated with these values correspond to the data on the signal.

Upper limits correspond to output of 20 mA.	Output_1_Low Output_1_Hi Output_2	The upper limit on the low range of output 1. The upper limit on the high range of output 1. The upper limit of output 2 channel.
Lower limits correspond to output of 4 mA. Limits are normally zero but may also be positive or negative values.	Offset_1_Low Offset_1_Hi Offset_2	The lower limit on the low range of output 1. The lower limit on the high range of output 1. The lower limit of output channel 2.

Figure 4-7.
Setpoints to be viewed and / or altered in Analog Range key.

Test/Config Key

All system configuration parameters, both critical (system constants and variables, calculation coefficients, configuration flags, etc.) and non-critical (time of day, date, etc.), are accessed through the **Test/Config** key. When you press the **Test/Config** key, you will have to enter a password (Level 1, 2, or 3) immediately. If the Level 1 password has been entered, a higher level password will be needed to select **Configure Menu**. The menu accessed when **Configure Menu** is chosen will be different depending on which password, Level 2 or Level 3, has been entered.

View Configuration

Selecting this menu item allows you only to view software configuration values. We recommend that you record system parameters periodically so you can reconstruct the configuration should the computer memory fail. You should also compare current software configuration periodically to the factory software configuration data sheet to verify that critical system values have not been changed. Note that it is normal to see a slight change in values for PolyCoeff_D and Moist_Span as these may be reset during verification cycles.

To view configuration values, press **Enter** to display the next parameter and press **Cancel** to return to the **Test/Config** main menu. The following parameters and data formats are displayed in the order shown

in (Figure 4-8).

Set Time of Day

At the "Enter New Time" prompt, enter a 4-digit time of day using the 24-hour clock convention. You do not have to enter punctuation between hours and minutes.

Set Date

At the "Enter New Date" prompt, enter a 6-digit date in the form MM/DD/YY. You do not have to enter punctuation between month, day, and year.

Set Auto Cal Time

At the "Enter New Time" prompt, enter the time of day you want the auto-calibration cycle to run (this becomes the value of the variable Cal_Time). Enter a 4-digit time using the 24-hour clock convention. You do not have to enter punctuation between hours and minutes. Cal_Time is used in conjunction with Auto_Cal_Cycle to set the interval in days between calibration cycles.

System Tests Menu

The 5000 Controller has numerous self-test routines that can be run periodically as part of regular maintenance or used to assist in troubleshooting the analyzer. The system tests are discussed in detail in Chapter 6.

Configure Menu

You can access both Level 2 and Level 3 Configure Menus using this menu item. Refer to Chapter 5, Software Configuration for more information on the Configure Menus and associated functions.

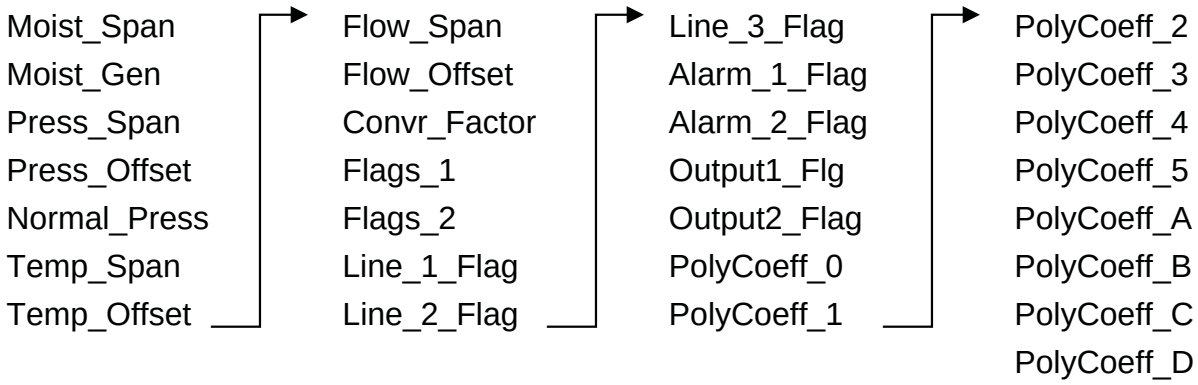


Figure 4-8.
Parameters and data formats for Test / Config key.

AMETEK 5000 Controller

Default System Security Passwords

Level 1:	1 1 1 1 [ENTER]
Level 2:	2 2 2 2 [ENTER]
Level 3:	.3 - 18 [ENTER]

SOFTWARE CONFIGURATION

You can customize the 5000 Analyzer to your preferences by changing the software configuration of the controller. Use the configure menus to alter various system parameters and constants and to assign flags to controller display, analog outputs, and alarms. To access the configure menus, press the **Test/Config** button. At the "Enter Access Code" prompt, enter the Level 2 or Level 3 password. Scroll down until **Configure Menu** is highlighted and then press **Enter**.


NOTE

You will access different Configure Menus depending upon which password you entered. The Level 3 password should be entered only if troubleshooting is needed or you need to access critical configuration parameters. The Level 3 password should be restricted to knowledgeable and authorized personnel.

Level 2 Configure Menu

Figure 5-1 shows the sub-menus of the Configure Menu when you enter the Level 2 password. Scroll up, down, left, and right until the desired menu item is highlighted and then press **Enter** to continue.

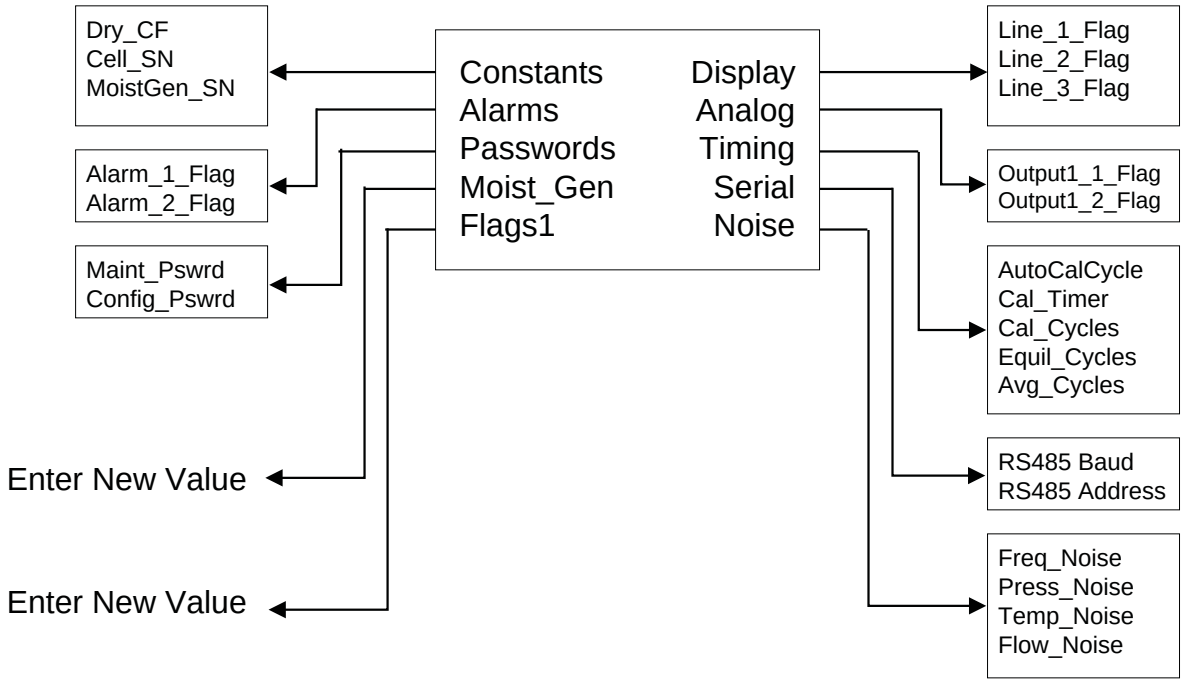


Figure 5-1.
Level 2 password
Configure Menu.

Constants

Dry_CF (Dry Cell Frequency)

The nominal cell frequency determined during factory calibration of the instrument. Given for informational purposes only.

Cell_SN

Number assigned to a particular cell calibration. Can be updated in configuration data file upon replacement.

MoistGen_SN

A serial number assigned to a calibrated moisture generator. Can be updated in the configuration data file when the generator is replaced.

Display (Display Flags)

This menu item is used to select the system values that are continuously displayed on the first three lines of the display screen.

- Select which line to alter by highlighting Line_X_Flag where X = 1, 2 or 3.
- Enter the flag value from the following list when the "New Value?" prompt is displayed.
- Press **Enter** to save change and return to the **Configure Menu**. Press **Cancel** to quit.

Except where noted (Figure 5-2), the same flags are used for the **Analog Output** and **Alarm Flags**.

Display Flag Values		Example of Display	
0	None		Blank
1	Held Moisture During Equilibration and verification	*	1.000 ppm Vol H2O
2	Live Moisture During Equilibration and verification	*	000 NOT USED
3	Cell Frequency (Cell_Freq) in Hz		12000 Hz Cell Freq
4	Delta Frequency (Delta_Freq) in Hz		0.50 Hz Delta Freq
5	Pressure (psia)	*	000 For Dew Point
6	Temperature (°C)	*	0000 NOT USED
7	Flow Rate (mL/min)	*	250 mL/min Flow
14	Status of Valve and Alarm Relays	**	010-Alr 00001010 Vlv
15	Period Timers & Cal_Time OR Cal_Timer	**	27-Ref 08:00-Cal, or
	(See note in "Timers")		27-Ref 003599-Cal
16	Output Range (Channel 1)	**	100.000 Rcdr Range

Figure 5-2.
Analog Output and Alarm Flags.

* These displays can be altered by the user. Refer to "Labels" in this chapter for more information on changing display formats.

** These flags are for display lines only, they do not apply to alarm or analog output flags.

Alarms (Alarm Flags)

The alarm flags are used to link a high concentration alert to any two of six system values.

- Select the alarm flag to alter by highlighting Alarm_X_Flag where X = 1 or 2.
- Enter the new flag value when the "New Value?" prompt is displayed.
- The values to be entered are identical to Display Flags 1 through 7 (Figure 5-2). Press **Enter** to save change and return to the **Configure Menu**. Press **Cancel** to quit.

Analog (Analog Flag)

This menu item is used to select the system values you can link to the 4 to 20 mA analog output.

- Select the output flag to alter by highlighting OutputX_Flag where X = 1 or 2.
- Enter the new flag value when the "New Value?" prompt is displayed.
- The values to be entered are identical to Display Flags 1 through 7 (Figure 5-2). Press **Enter** to save change and return to the **Configure Menu**. Press **Cancel** to quit.

Passwords

Highlight the password you want to view or alter. Press **Enter** to select. Enter a new 4-digit password when the "New Value?" prompt is displayed.

Press **Enter** to save change and return to the **Passwords Menu**. Press **Cancel** to quit. Refer to Chapter 4, System Security and Passwords for information on the various security levels.

Maint_Pswrd
View/alter the Maintenance Level (Level 1) password.

Confg_Pswrd
View/alter the Configure Level (Level 2) password.

Setting both the Level 1 and Level 2 passwords to "0000" disables low level security. These menus and system values can then be accessed without a password. Press **Enter** when the password prompt displays. You cannot alter the Level 3 password.

Timers

- Scroll through the following list of menu choices to highlight the desired menu item. Press **Enter** to select it.
- Enter the new timer value when the "New Value?" prompt is displayed.
- Press **Enter** to save the change and return to the **Configure Menu**. Press **Cancel** to quit.

AutoCalCycle

If you are running **Cal Cycle** less than once a day, enter the number of days to pass until the next cal cycle. This timer is used in conjunction with **Cal_Time**. **Cal_Timer** should be set to 000000.

Cal_Timer

Countdown time in seconds between cal cycles. When this timer reaches zero (times out), it will initiate a calibration cycle. Enter the new timer value in seconds when the "New Value?" prompt is displayed. Note that the value entered must be in 6-digit form, using lead zeros if necessary. **Cal_Time** should be set to 00:00.

Cal_Cycles

Number of complete cycles (moisture generator and reference periods) the analyzer will remain in calibration mode. Note that a typical complete cycle is 60 seconds for the standard timing cycle

Equil_Cycles

Number of complete cycles to allow for system equilibration before and after verification.

Avg_Cycles

Number of complete cycles used to average data when analyzer is configured to use enhanced noise smoothing. Refer to "Flags2" in this section for more information on configuring the analyzer to use enhanced noise smoothing. Enhanced noise smoothing will affect analyzer response time.

Cal_Time and Cal_Timer

The variable **Cal_Timer** should not be confused with the variable **Cal_Time**. If you need to run verification every day at the same time, set **Cal_Time** to the time for these cycles to occur. **Cal_Timer** should be set to 000000. If you need verification more often, set **Cal_Time** to 00:00 and **Cal_Timer** to the interval in seconds between cycles.

Moist_Gen

Select this menu item to change the value of the moisture generator stored in computer memory. This value should not be changed unless a special unit conversion, such as ppmv to lbs/mmcf, is required or if you replace the moisture generator. Enter the new moisture generator value when the "New Value?" prompt is displayed. Press **Enter** to save the change and return to the **Configure Menu**. Press **Cancel** to quit.

Serial

- Highlight the serial communication parameter to be viewed/altered. Press **Enter** to select it.
- Enter the new value for the parameter when the "New Value?" prompt is displayed.
- Press **Enter** to save the change and return to the **Serial Menu**. Press **Cancel** to quit.

RS485_Baud

Serial communication baud rate. Refer to the "Wiring Configuration and Baud Rate" in this chapter for the baud rate code to be entered. Note that the analyzer must be reset after the baud rate is set or changed. Reset the analyzer by cycling power or running the Watchdog Test (see Appendix A).

RS485_Address

Analyzer serial address in 3-digit form. If you are not using serial communication, set the address to 000. If one analyzer is on-line, the serial address is 200. Refer to the "Read and Write Protocol" in this chapter for information on addressing multiple analyzers.

Flags1 (Configuration Flags)

The **Flags1** value is a set of positions for eight bits (one byte) of computer logic. The value entered for **Flags1** is the sum of bit values for all of the features selected. Each bit position has a specific binary value when turned ON. All bits have a value of zero when turned OFF. Enter the new flag value when the "New Value?" prompt is displayed. Press **Enter** to save the change and return to the **Configure Menu**. Press **Cancel** to quit. Software configuration features (Figure 5-3) are selected or deselected by altering the value of **Flags1**.

Bit Value	Function
1	Enable Auto-Range for Analog Output 1.
2	Use Range Alarm for "data valid" signal to data acquisition system.
4	Use Concentration Alarm for "data valid" signal to data acquisition system.
8	Make alarm contacts normally open. Does not apply to the Watchdog Alarm.
16	Enable span adjustment during auto-cal cycle.
32	Make outputs track during auto-cal/auto-zero.
64	Display negative moisture value as zero.
128	Use non-verbose display mode for display line 4. Only system alarms will be displayed (no informational messages).

Figure 5-3.
Software configuration features and bit values.

Example

Features enabled are Auto-Range (bit value = 1) and Output Tracking (bit value = 32).

The new value for the **Flags1** = 1 + 32 = **33**

Noise

You can eliminate noise spikes that may occur in low absorbance applications by using the Infinite Impulse Response Filter formula. The values entered for **Freq_Noise**, **Press_Noise**, **Temp_Noise**, and **Flow_Noise** represent the multiplicative noise smoothing factors (between 0.1 and 1.0) for these parameters. The noise smoothing values are factory set to 1.0 which essentially disables noise smoothing.

- Highlight the variable to be altered.
- Press **Enter** to select it.
- Enter the new noise smoothing coefficient when the “New Value?” prompt is displayed.
- Press **Enter** to save change and return to the **Noise Menu**. Press **Cancel** to quit.

Level 3 Configure Menu

Figure 5-4 shows the sub-menus of the **Configure Menu** when you enter the Level 3 password. Scroll up, down, left, and right until desired menu item is highlighted and then press **Enter** to continue. The constants and variables altered in the Level 3 Configure Menu seriously affect analyzer function and signal processing. The default values for many of these variables are determined during factory calibration of the instrument.

CAUTION

Do not change the values of system constants and variables without fully understanding the effects on analyzer function and output data.

PolyCoef (Polynomial Coefficients)

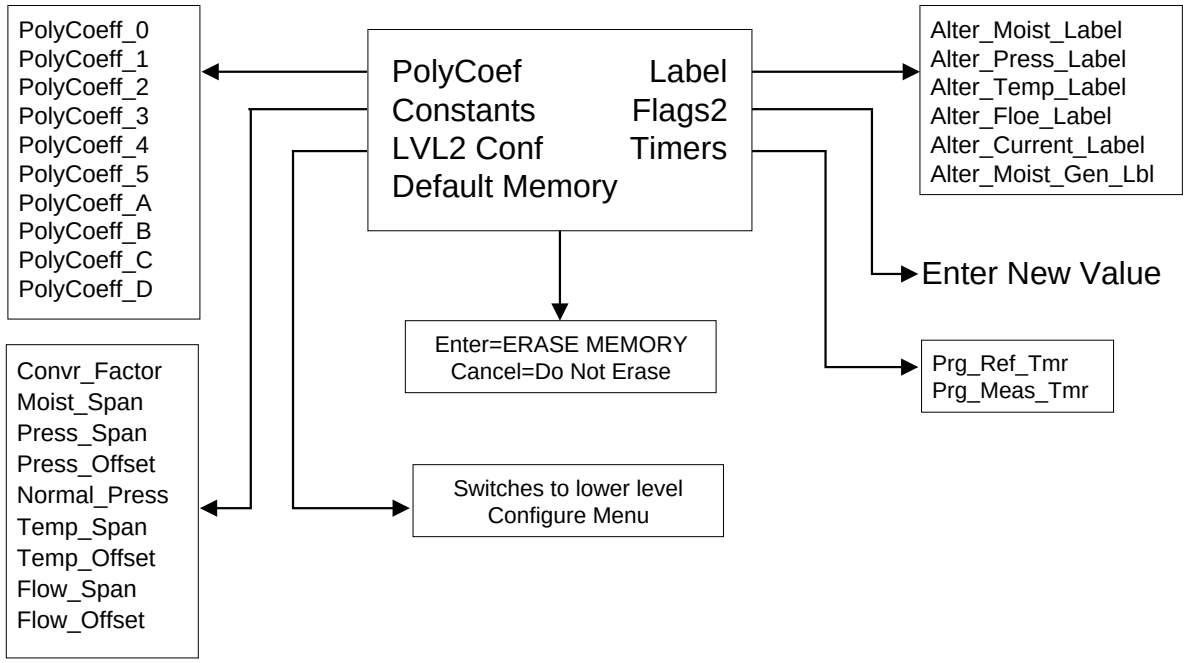


Figure 5-4.
Level 3 Configure Menu.

The polynomial coefficients used in the moisture concentration calculations vary from instrument to instrument and are determined during factory calibration. With the exception of Coefficient D, these values should never be changed unless factory service is performed or a major component is changed.

Select this menu item to alter the values of the polynomial coefficients contained in the formula you used to calculate moisture concentration.

- Press **Cancel** to scroll through the variables **PolyCoeff_X** where X = 0 through 5, A - D.
- Enter the new coefficient value when the "New Value?" prompt is displayed.

  The coefficients must be entered in decimal form i.e. 1234.56. The calibration report shows the coefficients in scientific notation i.e. 1.23456×10^3 in order to fit the form. To convert from scientific notation into decimal form, do the following: If the power number is positive, move the decimal point to the right as many spaces as the power number (3 spaces if the number is 3) and drop the X 10 ($1.23456 \text{ X } 10^3$ becomes 1234.56). If the power number is negative number move the decimal point to the left as many spaces as the power number and insert zeros to make up the spaces (3 spaces if the number is 3) drop the $\text{X } 10^{-3}$ (1.233456 X 10 becomes .00123456).
- Enter the new limit value when the "New Value?" prompt is displayed.
- Press **Enter** to save change and display the next coefficient. Press **Cancel** to quit.

Coef_D (Polynomial Coefficient D)

For low concentration applications (<1 PPM), the constant **Coefficient D** is used to correct for the offset between the sample and reference gases caused by the two gases being subjected to different outgassing mechanisms. Refer to Appendix E.

Labels

This menu item is used to change the text and format of the first three display lines.

- Highlight the label to be changed, press **Enter**.
- Use the left and right arrows to highlight the character to be changed and then use the up and down arrows to scroll through the list of available characters. Press **Enter** to select a character.

The character ~ indicates a placeholder for a numerical display including decimal points and negative signs with a total of eight places allowed.


NOTE

Do not erase the leading ~ placeholder.

- Add or remove a ~ placeholder from the right-hand side only. When finished, press **Enter** to save and **Cancel** to quit.

The following labels may be altered:

Alter Moisture Label (Line_X_Flag = 1: Held Moisture During Equilibration, and Cal)
Default: ~~~ ppm Vol H2O

Alter Pressure Label (Line_X_Flag = X: Cell Pressure)
Default: ~~~~~ NOT USED

Alter Temperature Label (Line_X_Flag = X: Cell Temperature in °C)
Default: ~~~~~~ NOT USED

Alter Flow Label (Line_X_Flag = X: Flow Rate)
Default: ~~~~~ NOT USED

Alter Current Label (Line_X_Flag = 2: Live Moisture including Equilibration and verification)
Default: ~~~~~~ Current H20

Alter Moist Gen Label (Displayed on Line 1 when moisture generator gas flows during cal)
Default: ~~~~~ Moist Gen ppm

Constants

Use the arrow keys to scroll through the following list of system constants until the item to be altered is highlighted. Press **Enter** to select. Enter the new constant value when the "New Value?" prompt is displayed. Press **Enter** to save the change and return to the **Constants Menu**. Press **Cancel** to quit.

Convr_Factor

Constant used to calculate moisture concentration. This value is factory-set and should not be changed unless factory service is performed.

Moist_Span

The constant cell verification factor. refer to Chapter 3.

Press_Span

For dew point calculation.

Press_Offset

For dew point calculation.

Temp_Span

Not used. Set to 0.

Temp_Offset

Not used. Set to 0.

Flow Span

Not used. Set to 0.

Flow Offset

Not used. Set to 0.

Flags2 (Configuration Flags)

The **Flags2** value is a set of positions for eight bits (one byte) of computer logic. Similar to **Flags1**, the value entered for **Flags2** is the sum of binary values for all of the features to be selected. Each bit position has a specific binary value when turned ON. All bits have a value of zero when turned OFF. Enter new flag value when the "New Value?" prompt is displayed. Press **Enter** to save change and return to the **Configure Menu**. Press **Cancel** to quit.

Bit Value	Function
1	Enable dew point calculation.
2	Enable vapor pressure calculation.
4	Use enhanced noise smoothing (Boxcar Averaging). *Note that a value must also be assigned to the timer Avg_Cycles to use this feature.*
8	Use bar (rather than psi absolute) for all pressure units.
16	NOT USED
32	NOT USED
64	Enable dew point calculation in °F.

Figure 5-5.
Flag2 functions and bit values.

Level 2 Confg Menu (Go to Level 2 Configure Menu)

When you press **Enter** with this menu item selected, you access the Level 2 Configure Menu immediately. Because the Level 3 password cannot be changed from the factory default, use this menu item to access Level 2 functions if the Level 2 password has been changed or forgotten.

Timers (Measurement Cycle Timers)

Changing these timers will affect the curve fit function used by the analyzer. Please consult AMETEK service before changing these timers.

Prg_Ref_Tmr
Reference measurement period in seconds.

Prg_Meas_Tmr
Sample measurement period in seconds.

Default Memory (Reset Controller to Factory Default Values)

Select this menu item to reset all system configuration parameters to factory-default values. Press **Enter** to reset and press **Cancel** to quit without resetting.

Before resetting the controller to default configuration, record current configuration values by selecting View Configuration from the ***Test/Config*** *Main Menu.*

Items marked with an asterisk (*) on the configuration data sheet supplied with the analyzer vary from system to system and are determined during the factory calibration of the instrument. When the system is reset to default values, these items must be entered manually to duplicate the original configuration of the specific analyzer.

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TROUBLESHOOTING AND MAINTENANCE

WARNING

Any troubleshooting or maintenance to this analyzer that requires access to the interior of the components must be performed only by qualified service personnel . There are no operator-level serviceable parts, expendables, or maintenance needs inside this analyzer.

System Alarms

The system alarm contacts are activated when there is a condition that makes the analyzer output questionable. The error messages in Figure 6-1 will be displayed on the bottom line of the analyzer display when a system alarm condition exists.

CELL TEMP ALERT	Moisture Cell temperature control is suspect (signal sent from field unit).
LOW CELL FREQUENCY	Activates when measured cell frequency is < 500 Hz.
HIGH CELL FREQUENCY	Activates when measured cell frequency is > 3500 Hz.
NEGATIVE DELTA FREQUENCY	Activates when delta frequency is < –1 Hz.
GEN TEMP ALERT	Moisture Generator temperature control is suspect (signal sent from field unit).
CAL ERROR	Activates when the new calculated span value (Moist_Span) exceeds the limits Max_Cal_Err or Max_Span. Refer to Chapter 4, "Alarm Button" for more information. Deactivates after successful calibration.
DISPLAY OVER-RANGED	A displayed value exceeds the allotted display area.
MEMORY IS CORRUPTED	The RAM or RAM battery has failed causing factory default parameters to be loaded into memory.

Figure 6-1. System Alarm error messages.

NOTE

It is common for some of these system alarms to activate momentarily during normal operation, especially during equilibration periods between measurement cycles. If the system alarm persists, there may be a problem with the measuring cell, the moisture generator, or the thermal controller.

Computer Operating Properly Alarm

This alarm, also known as the COP or watchdog alarm, activates when normal CPU logic flow is disrupted. Possible triggers of this alarm are:

- power failure
- internal power failure
- software problems, or
- extreme electronic interference.

When activated, the COP alarm generates a system reset but retains software configuration parameters. You do not have to reconfigure the system.

System Tests Menu

Numerous self-test routines can be run periodically or used to assist in troubleshooting the analyzer. Press the **Test/Config** key and enter the Level 1 or higher password. Scroll down to **System Tests Menu** and press **Enter**. Select a test from the following list and then follow directions displayed on screen.

Normal serial communications are disabled while system tests are running.

Test Display

Verifies that each segment of the display is functioning properly by displaying a checkerboard pattern for several seconds and then reversing it. Press **Enter** to begin test or **Cancel** to quit.

Test Analog Out

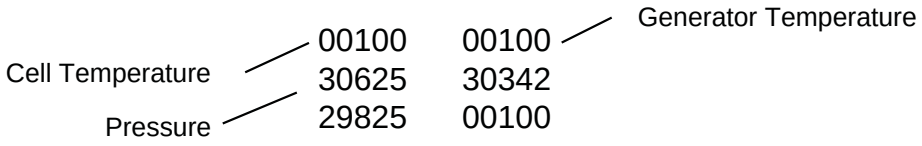
Sets the signal on the analog output to an mA value corresponding to any percentage of full scale for those outputs. Default percentage is 0% which sets the outputs to 4 mA. A different percentage from –15% to +100% may be entered at the "New Value?" prompt. Figure 6-2 lists the correct value of the 4 to 20 mA signal for various percentages. Press **Enter** to begin test or **Cancel** to quit.

% of Full Scale	% of Output (mA)	% of Full Scale	Output (mA)	Full Scale	Output (mA)
-15	1.6	25	8.0	65	14.4
-10	2.4	30	8.8	70	15.2
-5	3.2	35	9.6	75	16.0
0	4.0	40	10.4	80	16.8
5	4.8	45	11.2	85	17.6
10	5.6	50	12.0	90	18.4
15	6.4	55	12.8	95	19.2
20	7.2	60	13.6	100	20.0

Figure 6-2.
4 to 20 mA signal for percentage output.

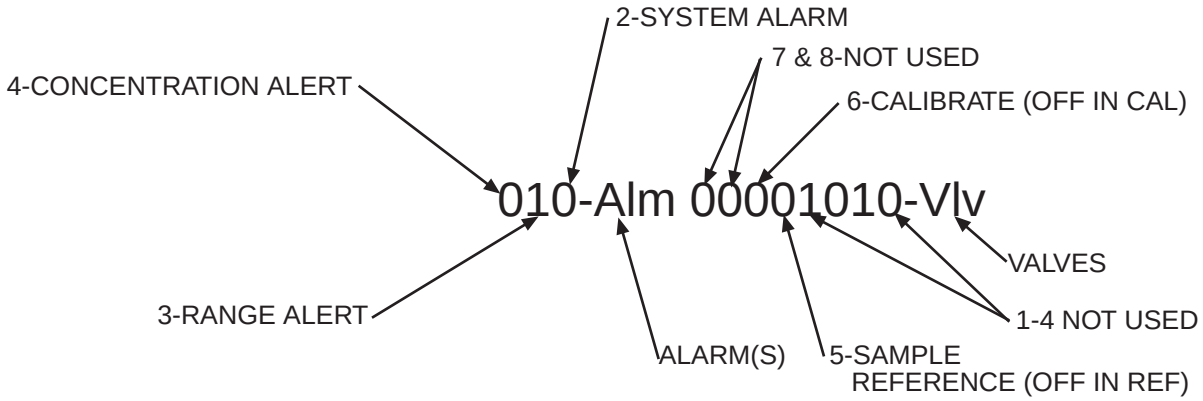
Test Analog Inpts

Verifies that alarm voltage signals from the cell and moisture generator ovens and process pressure transmitter (if live pressure input is being used) are present and tracking. Press **Enter** to begin test or **Cancel** to quit. First three lines of the display will appear as follows:



The numbers shown here are for example only. Count values in active input fields will be changing. A reading of 32,767 indicates an interruption of signal has occurred.

When running Test Valve Relays or Test Alarm Relays, it is useful to assign display flag 14, **Status of Valve and Alarm Relays**, to one of the display lines. The flagged display line will read as follows:



Test Alarm Relays

Verifies function of alarm contacts. All alarm relays are energized (= 1) when the test begins. At the "Number Key to Toggle?" prompt, press 2 for **System Alarm** contacts, 3 for **Range Alert** contacts, or 4 for **Concentration Alert** contacts. Press **Enter** to begin test or **Cancel** to quit. Selected alarm contacts will toggle to de-energized (= 0).

Test Valve Relays

Verifies function of valve relays. All valve relays are de-energized (= 0) when the test begins. At the "Number Key to Toggle?" prompt, enter the number of the relay to test (1 through 8). Press **Enter** to begin test or **Cancel** to quit. Selected valve contacts will toggle to energized (= 1).

Relay 6 has opposite logic. It will be energized when logic=0 and de-energized when logic=1

Test Watchdog

Verifies function of the **Computer Operating Properly** (watchdog) alarm by introducing an anomaly in the computer logic which should activate the alarm. If functioning properly, a system reboot will occur and the display will return to normal operating screen. If test fails, system will not reboot. Press **Enter** to begin test or **Cancel** to quit.

Test Serial Port

Verifies the data flow to the RS-485 serial port. The serial port connector must be removed from the port to run this test. If using the four-wire serial communication mode, you must provide a feedback loop by connecting 2W+/4WTX+ to 4WRX+ and 2W-/4WTX- to 4WRX-. Press **Enter** to begin test or **Cancel** to quit.

Test RAM

Verifies the operation of the computer's random access memory. At "System Will Not Run - Remove Power Now" prompt, turn off AC source. Wait at least 20 seconds and turn on power. If RAM test is successful, "RAM Tested Good - Enter To Continue" will be displayed. Press **Enter**. Boot-up information will be displayed for several seconds and then the display will return to normal operation screen. This test runs every time the analyzer is rebooted.

Scheduled Maintenance

Weekly

- Operate internal generator to verify calibration.
- Adjust Span, if necessary.

Quarterly

- Perform system inspection and leak check.
- Replace the filter frit.

Yearly

- Replace or refill the dryer molecular sieve.
- Replace or refill the trap's activated charcoal.
- Replace the super dryer.
- Refill the moisture generator with distilled or deionized water (>12 Mohms resistivity).
- Replace scrubber cartridge (use only with acid gas option). See Appendix B.

System Inspection

Inspection and maintenance should be done only by qualified personnel.

1. With Snoop® PN 202887000 or a soap solution, check the sample line for leaks.

2. Verify that flowmeters, regulators, valves, gauges, and filters are in good condition and securely mounted.

3. Verify the integrity of all power supply and interconnecting wiring. Check the circuit cards in the field unit and controller for signs of overheating or contamination. Use clean, low pressure air to blow off any accumulated dust and debris.

4. Repair or replace any damaged part. Correct any unsatisfactory condition as necessary.

5. Exterior enclosures of the field unit and sample system can be cleaned with mild, non-abrasive detergent or spray cleaner. The controller enclosure can be cleaned in the same manner but the cleaner must not be sprayed or applied directly. Moisten the applicator first before cleaning.

Troubleshooting Guide for 5000 Analyzer

Possible Cause	Isolation Procedure	Corrective Action
Field Unit LEDs do not light		
Blown fuse F1		Replace F1.
Blown thermal cutoff S2		Replace S2
Faulty power supply Fault connections	Check for 24 VDC between red and black test points TP2 (+) and TP1.	If voltage is not present and CB1 is closed, check power supply of T1 and diodes CR4 and CR5.
Controller Alarms not operating		
Incorrect operating parameters		Check and secure all connectors between boards. Check that all relays are secure. Verify software parameters.
Faulty relay	Perform **Test Alarm Relays** routine	If relay works, place analyzer on-line. If relay does not function, replace the CPU board.
Faulty CPU board		Replace CPU board.
Display Reads Low in calibrate or operate modes		
Incorrect operating parameters		Check all values against Calibration Data Sheet.
Incorrect back pressure		Check, and if necessary, reset back pressure.
Incorrect sample flow rate	Check flow rate with Bubble-O-Meter	Reset flow, if necessary.
Incorrect operating temperatures	Check and, if necessary, set oven and	moisture generator operating temperatures.
Contaminated sample cell crystal	Read cell frequency	If cell frequency input is >3500 Hz, replace the cell.
Contaminated dryer	Substitute with known good dryer.	Replace or re-activate dryer.

Troubleshooting Guide for 5000 Analyzer		
Possible Cause	**Isolation Procedure**	**Corrective Action**
Analyzer Reads High		
Incorrect flow rate		Check, and if necessary, reset flow rate.
Incorrect back pressure		Check, and if necessary, reset back pressure.
Incorrect operating parameters		Check all values against Calibration Data Sheet.
Leaks in sample tubing		Correct leaks as necessary.
Low oven temperature		Set oven temp to 60 °C ± 0.25 °C.
Moisture Generator Output Reading Incorrect		
Incorrect flow rate or back pressure		Check, and if necessary, reset flow rate or back pressure.
Incorrect operating parameters	Calibration has exceeded Max_Span and/or Max_Cal_Err limits.	Check all values against Calibration Data Sheet.
Incorrect calibration values entered		Run display routine and check all values against those listed on Calibration Data Sheet. Re-enter values if necessary. Recalculate Span values.
Dry moisture generator reservoir	Check flow rates, generator temperature, and back pressure unit board.	If reading are OK, check, and if necessary, fill the reservoir.
Incorrect moisture generator temperature	Measure temperature of moisture generator J2 Pins 2 and 3 of field unit board.	Adjust R26 on field unit board as necessary to obtain 60 °C.
Faulty reservoir tubing bundle		Replace generator.
Cell_Temp_Alert		
Environmental Temp	Check for CR1 blinking	Housing or ambient temperature is too hot or too cold for the electronic control amplifier to control cell temperature.
Faulty electronic control ampplifier	Remove cell oven connector J1, CR1 will go on short pins 1 and 4 together on the electronic control amplifier PCB and CR1 will go off.	If not, replace electronic control amplifier PCB.

Troubleshooting Guide for 5000 Analyzer		
Possible Cause	**Isolation Procedure**	**Corrective Action**
Gen Temp Alert		
Environmental Temp	Check for CR14 blinking	Housing or ambient temperature is too hot or too cold for the electronic control amplifier to control moisture generator temperature.
Faulty electronic control amplifier PCB	Remove moisture generator cable J2, CR14 will go on. Short Pins 2 and 3 on electronic control amplifier PCB, CR14 will go off.	If not, replace electronic control amplifier PCB.
Faulty moisture generator heater thermistor	Remove J2 and check Pins 1 and 4 for 28Ω.	If not, replace a moisture generator heater assembly.
Faulty moisture generator thermistor	Remove J2 and remove thermistor from moisture generator, check for =100KΩ @ 23 °C.	If not 100KΩ, adjust R26 as necessary. If adjustment will not work, isolate either the moisture generator heater or field unit board.
Low Cell Frequency		
Faulty Cell		Replace cell.
High Cell Frequency		
Contaminated sample cell		Replace cell.
Contaminated dryer and/or trap		Replace trap and/or dryer and flush out sample system.
Excessive moisture	Leak test system	Dry-down system.
	Verify sample gas is not above analyzer specifications.	Dry-down system.
Negative Delta Frequency		
Incorrect flow rate or reference leak		Verify and adjust flow rates.
Faulty dryer	Substitute dryer with known good one.	Replace and/or refill dryer.
	Supply known dry sample.	Replace and/or refill dryer.
Memory Is Corrupted		
Faulty RAM or RAM battery		Replace battery.


NOTE

To ensure correct moisture operation, refer to "Display Reads Low in Calibrate or Operate Modes," or "Moisture Generator Output Incorrect."

Field Unit Electronics

Power Distribution

- The AC supply is applied through circuit breaker CB1 and thermal cutout S2 to the primary of transformer T1.
- The T1 secondary (35 VAC) is connected directly to rectifier and regulator circuits on the electronic control board.
- Diodes CR4 and CR5 supply unregulated +24 volts and feed the series-connected voltage regulators.
- VR1 supplies +12 volts and VR2 supplies +5 volts.
- Diodes CR2 and CR3 supply unregulated +24 volts for the cell oven.
- CR15 and CR16 supply unregulated +24 volts for the moisture generator oven.

Power distribution failure symptoms

- Valves do not switch, but output reading could be on display.
- One or more LEDs do not light, depending on faulty circuit.
- No moisture generator heat.
- No oven heat; CR1 and CR14 on steady.

Electronics control board voltage checks

- +5 volts — TP5 J7
- +12 volts — TP4 J6
- +24 volts — TP2 J4 (0 volt — TP1 J3)

Heat Control

There are two, identical, +24-volt heat control circuits: one for the cell oven and one for the moisture generator. Each has a heater, an inverting amplifier (U1 or U2), a thermistor (RT1 or RT2), a triac (Q1 or Q2), an LED (CR1 or CR14), a temperature adjustment pot (R17 or R26), and miscellaneous resistors and capacitors.

- The thermistor has a negative coefficient: heat decreases, resistance increases. This decreases the voltage to its amplifier, making the output go high, gating the triac on, applying +24 volts to the heater.

- As less heat is needed, the reverse occurs. Capacitor C6 (C9) and resistor R20 (R28) provide positive feedback to start U1(U2) oscillating and to establish a time constant for frequency control. These oscillations gate the triac on and off at a control frequency rate so that heat increases and decreases gradually. The LED lights when heater voltage is on.

The outputs of U1 and U2 also are fed to dual pulse detector U3. If an output is steady-state [(not oscillating) (fault)], a Q output of U3 turns off either transistor Q7 or Q8, which generates a fault number.

There also is a field unit environmental heater comprised of resistors R1 and R2 and a 40 °C thermostat switch S1.

Solenoid Control

There are two, similar, +24-volt solenoid circuits: one cycles wet/dry solenoids L1 and L2 and the other operates the moisture generator/sample flow solenoids simultaneously. Their circuits include transistor switches, diodes, LEDs, and current limiting resistors.

With no valve signal (0 volt) at TB1-7, transistor switch S6 is biased on, grounding the control side of the solenoid L1 winding and lighting LED CR11. Sample gas flows through the cell.

Every 30 seconds, +5 volts is applied to transistor Q5, turning it on, grounding the control side of solenoid winding L2 and LED CR10. The solenoid opens reference gas flow through the cell, and the LED lights.

In normal operation, +5 volts is on TB1-8, biasing transistor switch Q4 on, turning Q3 off, de-energizing solenoids L3 and L4, allowing sample gas to flow. Pressing the MOIST GEN key applies 0 volt to the base of Q4, turning it off. This turns Q3 on, grounding the control sides of L3 and L4, opening moisture generator gas flow.

Cell Output

There are two crystal oscillator (Y_1 — reference and Y_2— measure) circuits with amplifier/inverters U1 and U2 and rc filters. Except for their frequencies, the two oscillators function alike.

U2A-1/-2 and U2F-13/-12 provide positive feedback to sustain the Y_1

(Reference) and Y_2 (Measure) nominal oscillations at 8.982500 MHz and 8.982000 MHz, respectively.

U2B/C and U2E/D amplify the outputs.

Assuming a dry Y_2 frequency of 8.982000 MHz, (L2 energized) and a Y_1 frequency of 8.982500 MHz, low pass filter C9 develops a difference frequency of 500 Hz (DF_2). This frequency is amplified to produce a square-wave voltage of 0 to 12 at 500 Hz applied to the controller processor.

During the 30-second wet cycle, moisture is sorbed in the crystal cell which adds to its weight. The additional weight decreases the frequency to 8.981000 MHz (assumed), which produces a wet difference frequency (DF_1) of 1500 Hz (8.982500 – 8.981000 = 0.0015 MHz). This frequency is amplified and applied to the microprocessor as a square-wave voltage of 0 to 12 at 1500 Hz.

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Insert from the schematics file 11 x 17 fold out page.

Figure 6-3.
5000 Field Unit schematic
sheet 1 of 2.

Insert from the schematics file 11 x 17 fold out page.

Figure 6-4.
5000 Field Unit schematic
sheet 2 of 2.

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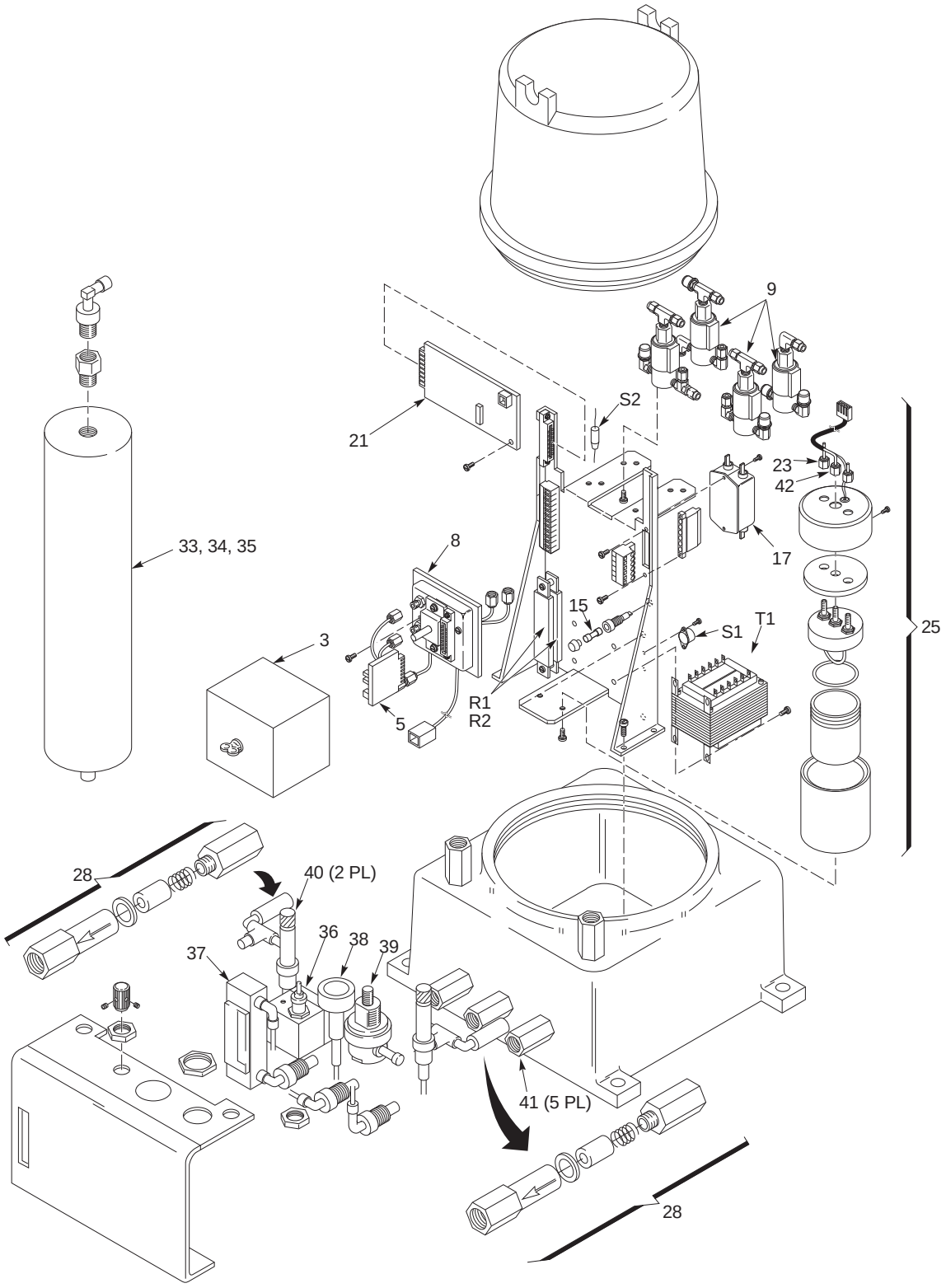


Figure 6-5.
Field Unit parts replacement.

Field Unit

Numbers in parentheses refer to find numbers in Figure 6-5.

WARNING

The Field Unit may contain flammable or toxic process gas. Remove the lid in a well-ventilated area only after electrical power is shut off and the surrounding area in known to be non-hazardous.

NOTE

The lid weighs 8.2 kg (18 pounds). Handle with care.

Lid Removal

1. Shut off system power and sample and reference gas flows at their sources.
2. Unscrew the lid (1), using a bar across the slots on the top if required.
3. Carefully lift off the lid and set it aside.

Cell Replacement

1. Shut off system power and sample and reference gas flows at their sources.
2. Carefully remove the lid and set it aside.
3. Remove the oven cover wing nut (2); tilt the cover (3) up and carefully slide it from the assembly.
4. Loosen the two tubing nuts (4) and disconnect the lines.
5. Unplug the cell and board (5).
6. Carefully plug the new cell and board into its connector.
7. Connect and secure the two tubing nuts.
8. Install the oven cover and wing nut.
9. Do a leak test and re-install the lid.
10. Apply power and verify flows, back pressure and cell frequency.
11. Input new cell poly coefficients per instructions on page 5-9.

Cell Oven Replacement

1. Shut off the system power and sample and reference gas flows at their sources.
2. Carefully remove the lid and set it aside.
3. Remove the wing nut (2) from the oven cover.
4. Tilt the cover up and carefully remove it from the assembly.
5. Loosen the two tubing nuts (4), disconnect the lines, and unplug the cell board (5).
6. Remove the plugs (6 and 24) from electronics control board sockets J1 and J2, and unplug the control board.
7. Loosen the tubing nuts (8A) and disconnect the tubes from solenoids SV1 and SV2 and from the lower part of the oven assembly.
8. Disconnect the oven wires from TB1-4 and -5.
9. Remove the oven mounting screws (7) and lift off the oven assembly (8).
10. Carefully hand bend the two oven lines to match the original installation as near as possible to preclude interference with the control board and the oven cover.
11. Position the new oven assembly on the bracket and install the screws.
12. Connect the lines to the solenoids and to the lower part of the oven assembly. Secure the tubing nuts.
13. Reconnect the oven wires to TB1-4 and -5.
14. Insert the control board in its socket and connect the plugs to J1 and J2. Secure the screws.
15. Install the cell board and connect and secure the two tubing nuts.
16. Install the oven cover and wing nut.
17. Do a leak test and re-install the lid.
18. Apply power to the system, allow it to warm up, and resume operation.

Moisture Generator Sample/Reference Valve Assy

1. Shut off system power and sample and reference gas flow at their sources.
2. Carefully remove the lid and set it aside.
3. Loosen the tubing nuts from the fittings (10).
4. Disconnect the solenoid wires from TB2 (11).
5. Remove the two mounting screws (12) and the valve assembly (9).
6. Position the new assembly on the chassis and install the mounting screws.
7. Connect the solenoid wires to TB2.
8. Connect and tighten the tubing nuts.
9. Do a leak test and re-install the lid.
10. Apply the power to the system, allow it to warm up, and resume operation.

Electronics Control Board

1. Shut off system power and sample and reference gas flows at their sources.
2. Carefully remove the lid and set it aside.
3. Disconnect the plugs from J1 and J2.
4. Remove the two screws (22), pull the board slightly forward to clear the bracket, and pull the board from its connector.
5. Firmly press the new board into its connector and install the two screws.
6. Connect the plugs to J1 and J2.
7. Re-install the lid.
8. Apply power to the system, allow it to warm up, and resume operation.

Thermal Cutout Link S2

1. Shut off system power.
2. Carefully remove the lid and set it aside.
3. Determine reason for thermal runaway inside of the field unit. S2 is a 72 °C device. Inside temperature is normally regulated at 40 °C.
4. Disconnect the link from TB3-5 and -6.
5. Connect the new link to TB3-5 and -6.
6. Re-install the lid.
7. Apply power to the system, allow it to warm up, and resume operation.

Moisture Generator Reservoir Refilling

Perform this procedure as quickly as practicable to keep downtime to a minimum and heaters from cooling.

1. Shut off system power.
2. Carefully remove the lid and set it aside.
3. Remove the thermistor from the top of the moisture generator with a $^{7}/_{16}$-in. wrench; pull the thermistor straight out.
4. Obtain a syringe (5 or 10 mL) and a $^{1}/_{16}$-in. plastic tubing to fit the nozzle. Cut the tube to a length so that it reaches a nominal 0.75 inch straight into the generator.

Take care you do not puncture the permeation tube inside the generator.

5. Insert the tube straight into the generator a nominal 0.75 inch and withdraw the syringe piston.
   - If you draw water into the tube, the generator water level is good.
   - If you do not draw water into the tube, continue.

6. Fill the syringe with distilled or deionized water and fill the generator until you can withdraw water down to the halfway point. Level must be at the halfway point.
7. Install the thermistor and tighten the fitting.
8. Re-install the lid.
9. Apply power to the system, allow it to warm up, and resume operation.

Filter Frit (PN 560503901) Replacement

1. Shut off sample and reference gas flows at their sources.
2. Disconnect the inlet tube.
3. Remove the filter (28) and unscrew the end (30).
4. Tap the filter against a bench to remove the frit (31).
5. Install a new frit. Be sure that the open end of the frit is in the direction of the arrow on the filter.
6. Assemble the filter and install it in the line.

Dryer or Trap Refilling


NOTE

If the dryer or trap is to be moved to another area to replace the molecular sieve in the dryer or the activated charcoal in the trap, place caps over the fittings while transporting the unit. This will prevent fitting damage.

1. Shut off sample and reference gas flows at their sources.
2. Unscrew the two ferrule nuts (32) and disconnect the two lines from the dryer or trap.
3. Unstrap the dryer or trap (33) from its mount.
4. Remove the fill plug (34) and the snubber (35), and empty the contents.
5. Clean the inside thoroughly (do not use water). Be sure it is completely dry.
6. Fill the dryer with new molecular sieve (dried), or fill the trap with new activated charcoal.
7. Install the fill plug and snubber.
8. Do the following to the superactivated dryer:

   - Attach the bottom fitting to a flowmeter with a valve.

- Carefully place the cylinder in an oven with a source of dry gas < 0.1 PPM (known good superactivated dryer) connected to the top fitting.

Make sure that one end fitting is open before applying heat to the cylinder. If the sieve is moisture-laden and the fittings are capped, the cylinder could explode when heated.

- Adjust oven heat to 125 °C and purge flow to 100 mL/min. Allow it to run at temperature for 12 hours.

- Shut off purge and oven heat, and allow the cylinder to cool for at least one hour.

Wear gloves. The cylinder will still be hot.

- Disconnect and cap both ends and remove the cylinder from the oven.

9. Install the unit and connect the lines.

Leak Testing

1. Carefully remove the lid and set it aside.
2. Cap the back pressure exhaust and reference gas inlet tubes.
3. Apply 200 kPa (30 PSI) gauge instrument air pressure to the sample inlet.

Pressures over 30 PSI could destroy the gauge.

4. Close the Sample gas flow control valve while maintaining the applied pressure in the analyzer.
5. Generously apply a soap solution to all gas connections fittings. Check for leaks and tighten fittings if necessary. Wipe off excess liquid.
6. Repeat Steps 3, 4, and, if necessary, Step 5.
7. Re-install the lid.

Valve Operation and Heater Cycling

The field unit may contain flammable or toxic process gas. Remove the field unit lid in a well-ventilated area only after disconnecting power.

Check valve solenoid and heater operation by removing the lid and observing the LEDs.

Oven Temperature Adjustment

Perform this procedure as quickly as practicable to keep cooling from affecting the readings.

1. Carefully remove the field unit lid and set it aside.
2. Remove the plug from electronic control board socket J1.
3. Quickly connect a DVM, set to read ohms, between pins P1-1 and -4 (on body of J1) and check for the resistance specified on the oven thermistor label (also on J1), ± 200 ohms.
4. If necessary, adjust R17 one turn for each 1000-ohm (»1°C) difference between the specified and actual resistances. (Turn clockwise to decrease resistance.)
5. Remove the DVM and connect the oven plug to J1.
6. Re-install the lid.
7. Apply power to the system and allow it to warm up.
8. If necessary, repeat the procedure until no further adjustment is required to maintain 60 °C.

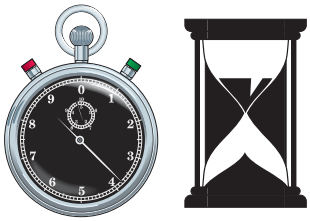
Moisture Generator Temperature Adjustment

Perform this procedure as quickly as practicable to keep cooling from affecting the readings.

1. Carefully remove the field unit lid and set it aside.
2. Remove the plug from electronic control board socket J2.
3. Quickly connect a DVM, set to read ohms, between pins P2-2 and -3 and check for the resistance specified on the moisture generator label, ± 200 ohms.
4. If necessary, adjust R26 one turn for each 1000-ohm (»1°C) difference between the specified and actual resistances. (Turn clockwise to decrease resistance.)

5. Remove the DVM and connect the moisture generator plug to J2.
6. Re-install the lid.
7. Apply power to the system and allow it to warm up.
8. If necessary, repeat the procedure until no further adjustment is required to maintain 60 °C.

?? ANSWERS TO YOUR QUESTIONS ??



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WE'RE THERE FOR YOU

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ANYTIME / ANYWHERE

AMETEK SERVICE & AFTERMARKET SALES SUP-

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To ensure you order the correct analyzer with the options your operation requires, schedule a factory-trained Service Engineer to inspect the proposed analyzer location. The on-site charge for this visit can be deducted from the start-up charge if you select that option.

• START UPS

Your decision to buy an AMETEK analyzer is greatly appreciated. After spending time and money on your analyzer, wouldn't you expect a fast and successful start-up? We can ensure that will happen! Schedule us to be there before you power up the system. We will guarantee a satisfactory commissioning of your analyzer.

• WARRANTY VALIDATION

Upon start up, we will validate your 1-year warranty. This validation enables you to extend your warranty for 2 or 3 years. AMETEK's warranty policy covers all parts, on-site time and travel time. Incurred costs are the responsibility of the customer.

• WARRANTY EXTENSIONS

AMETEK offers a 2- or 3-year warranty extension for your analyzers. The warranty is identical to the original policy supplied with the analyzer.

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455 Corporate Blvd., Newark, Delaware 19702
Telephone: (302) 456-4400 Toll Free: (800) 537-6044
Fax: (302) 456-4444

SERVICE AND PARTS REPLACEMENT

Service

If the 5000 Field Unit or Controller is not operating to specifications and the calibration/maintenance procedures contained in this manual do not solve the problem, please contact the nearest AMETEK regional office on page ii.

To ensure prompt service, please have the following readily available:

- Instrument type and model number
- Instrument serial or sales order number

Field Unit Parts List

Item #	Unit	Part Number
3	Oven Cover Assy	560057902
*5	Crystal Cell Assy, Standard Timing	563075928
	Crystal Cell Assy, H2S Standard Timing	563075930
	Crystal Cell Assy, Asymmetric Timing	563076929
	Crystal Cell Assy, H2S Asymmetric Timing	563076931
	Crystal Cell Assy, CO2 Asymmetric Timing	563076932
8	Cell Oven Assy	560015901
9	Solenoid Valve	258156000
	Rebuild Kit, Solenoid Valve	206846000
15	Fuse F1, 2A (for 115 V-Operation), “M” or “T” Type	205224050
	Fuse F1, 1A (for 230 V-Operation), “M” or “T” Type	205224039
*21	Control PC Board Assy	560039905
25	Moisture Generator assy, Heated	
	Nominal 20 ppm	560086901
	Nominal 3 ppm	560086902
36	Flow Controller, MG, SST	280807001
*28	Inline Filter, SST With 7-µm Frit	258882001
	Rebuild Kit Assy, Frit and Gasket	560503901
37	Flowmeter, 0 to 250 mL/min	209732002
	Flowmeter, 0 to 500 mL/min	209732001
	Flowmeter, 0 to 900 mL/min	209732003
38	Pressure Gauge, 0 to 200 kPa (0 to 30 psi)	251744000
39	Back Pressure Reg, 0 to 200 kPa (0 to 30 psi)	560299000
40	Metering Valve, SST	258888000
S1	Thermostat	259959000
T1	Power Transformer	500161901S
33	External Dryer, 3A Sieve	560040901
*	Molecular Sieve Desiccant, 2.2-kg (5-lb) can	207599000
*34	External Dryer, Superactivated	560040904
35	Contaminant Trap	560040903
*	Activated Charcoal, 1.8-kg (4-lb) can	206478000
S2	Thermal Cutoff, 72°C Max	270059001
17	Line Filter FL1	280107000
R1, R2	Resistor	250274000
41	Flame Arrestor	560350901

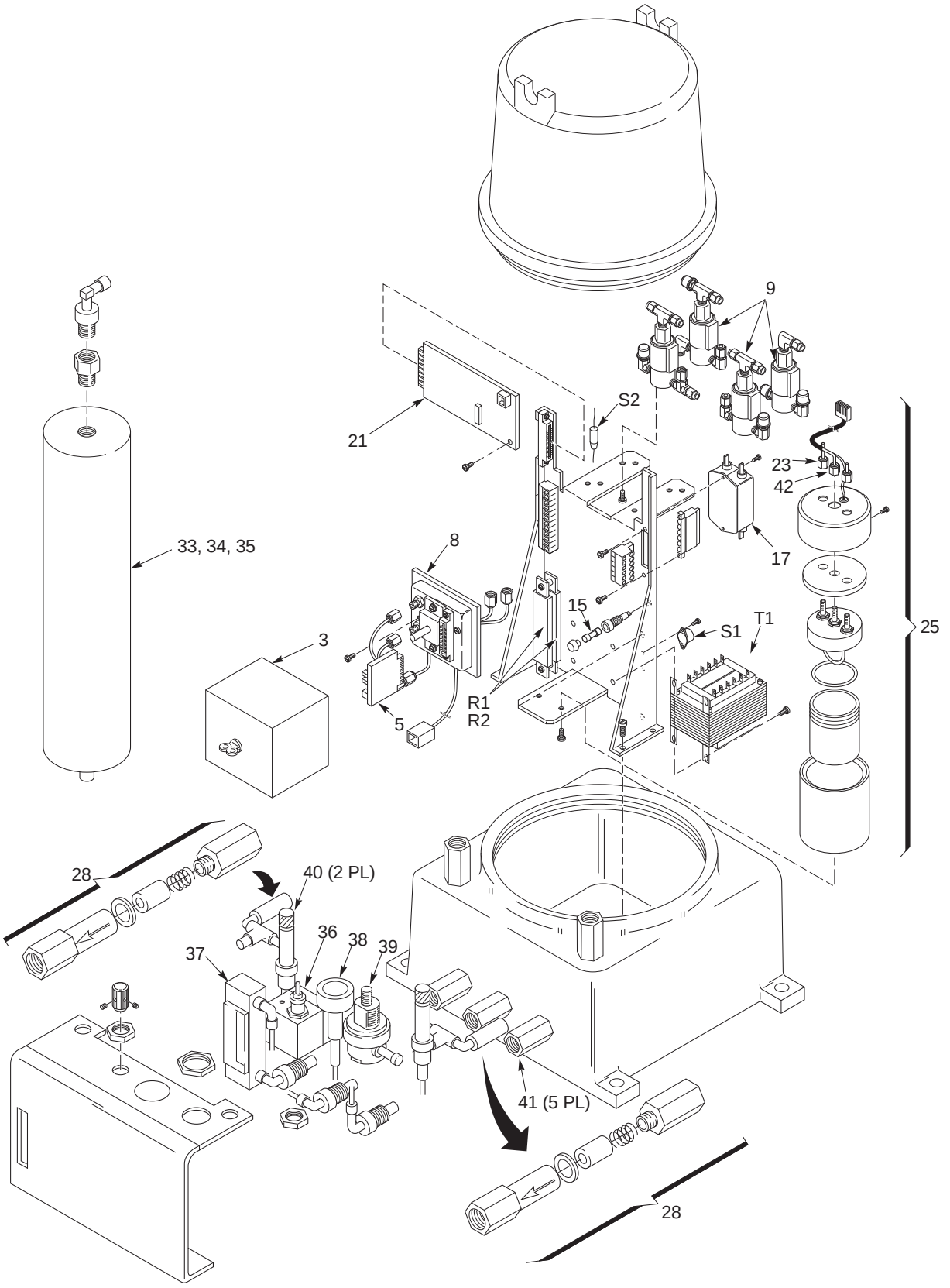

Figure 7-1.
Replacement parts locations.

Controller Parts List

Item No.	Unit	Part Number
*1	CPU Board (less EPROM)	804400901
2	Display Board	42373JE
*3	EPROM	500110902S
4	PC assembly relay/driver/memory	80499SE
5	Power Supply/Keyboard and Module	500124901
6	PC bd Wiring Module	80498SE
	Fuse f1-f8, 1.0A, 250Vac, Round, PC mount	25422JE
7	Dual Current Output Card (for 3 and 4 point systems)	80455SE

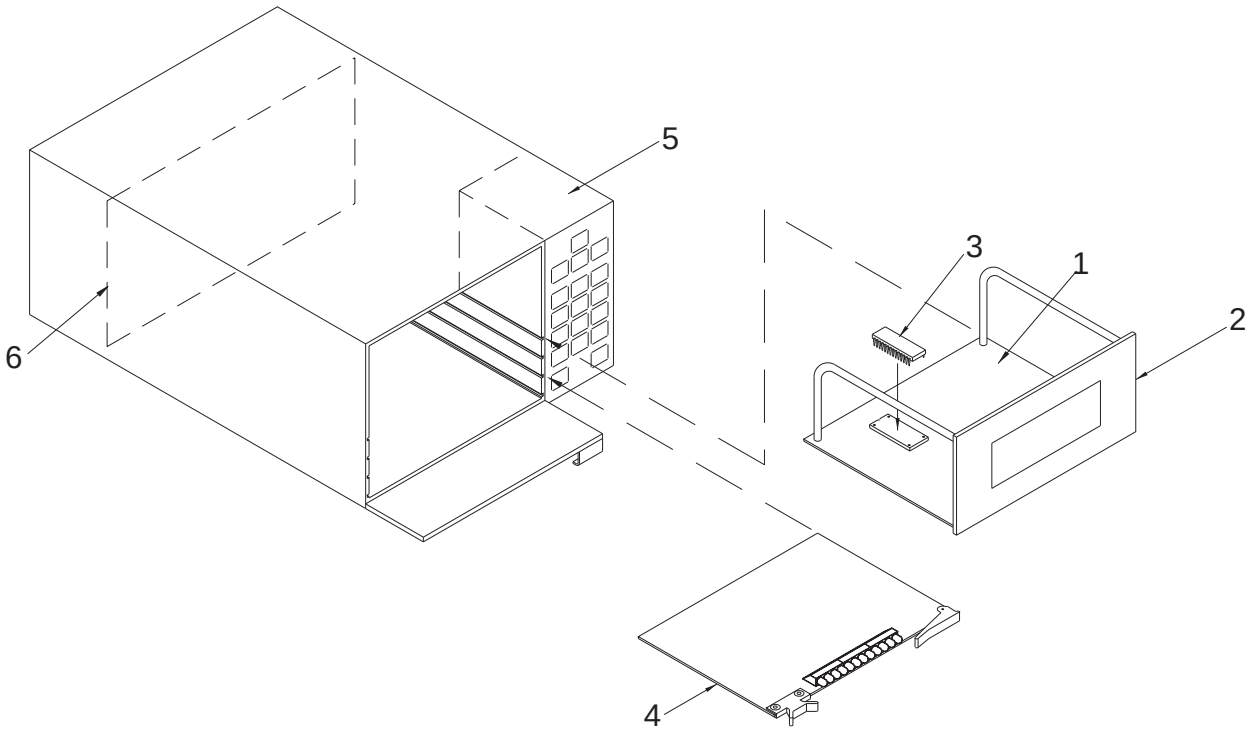

Figure 7-2.
Location of controller parts.

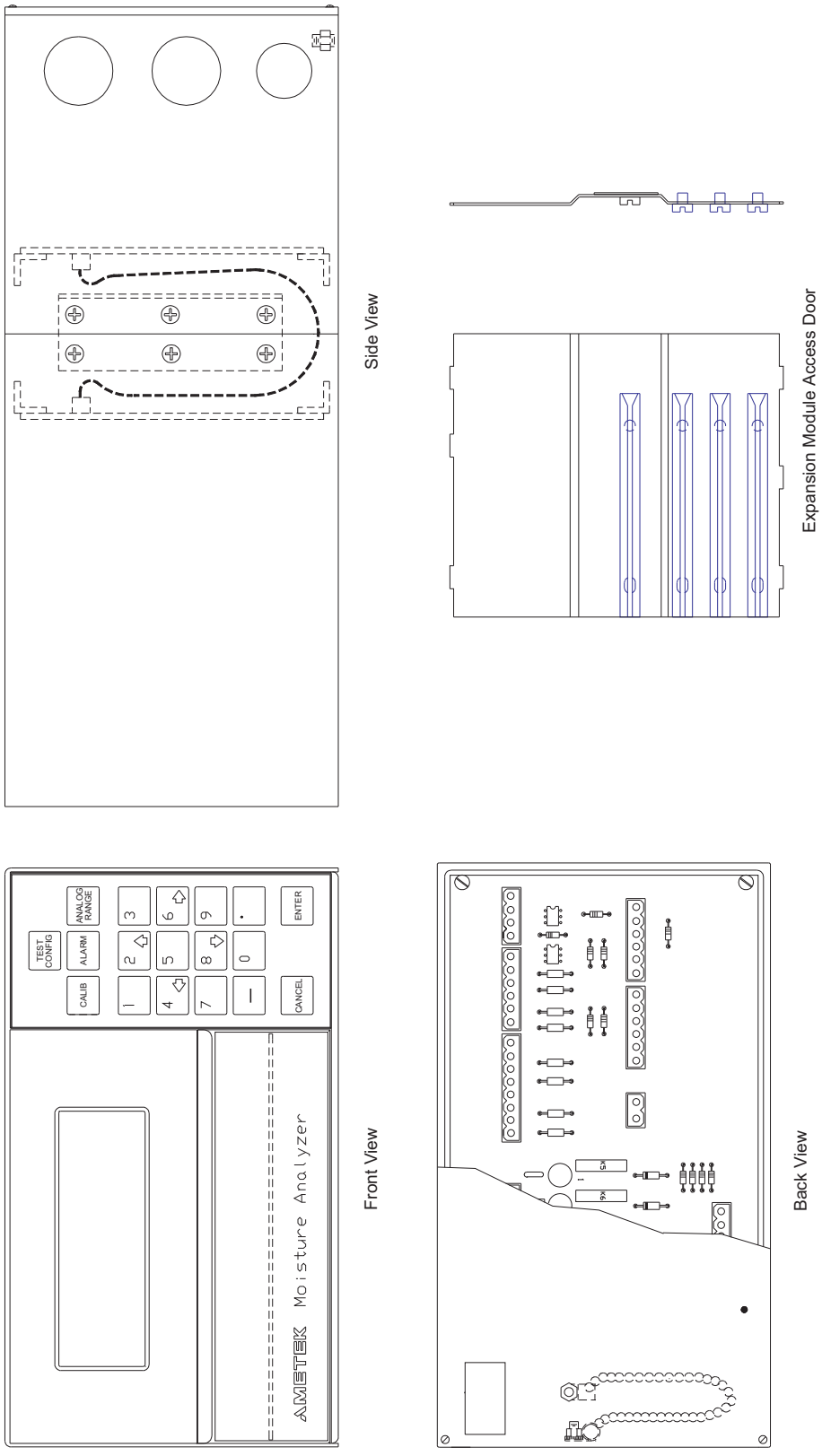

Figure 7-3.
5000 Controller.

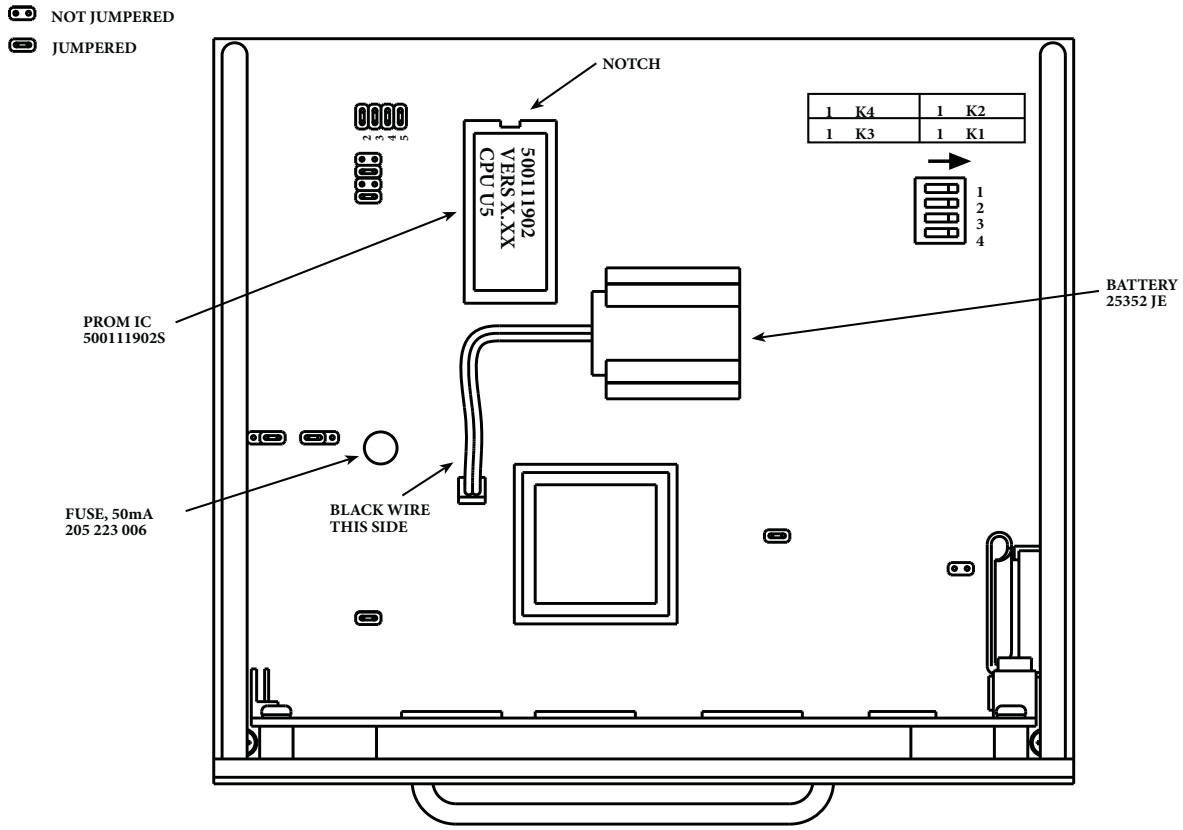

Figure 7-4.
CPU/Display PC board.

LEDs

LED1 through LED 4 = Not Used

LED5 = Sample Reference

When the light is ON, System is in Reference cycle. When OFF, System is in Sample cycle.

LED 6 = Calibrate

When the light is ON, the Moisture Generator is off. When the light is OFF, the Moisture Generator is on for period of Cal Cycle or however long it is left on manually.

LED7 through LED12 = Not Used

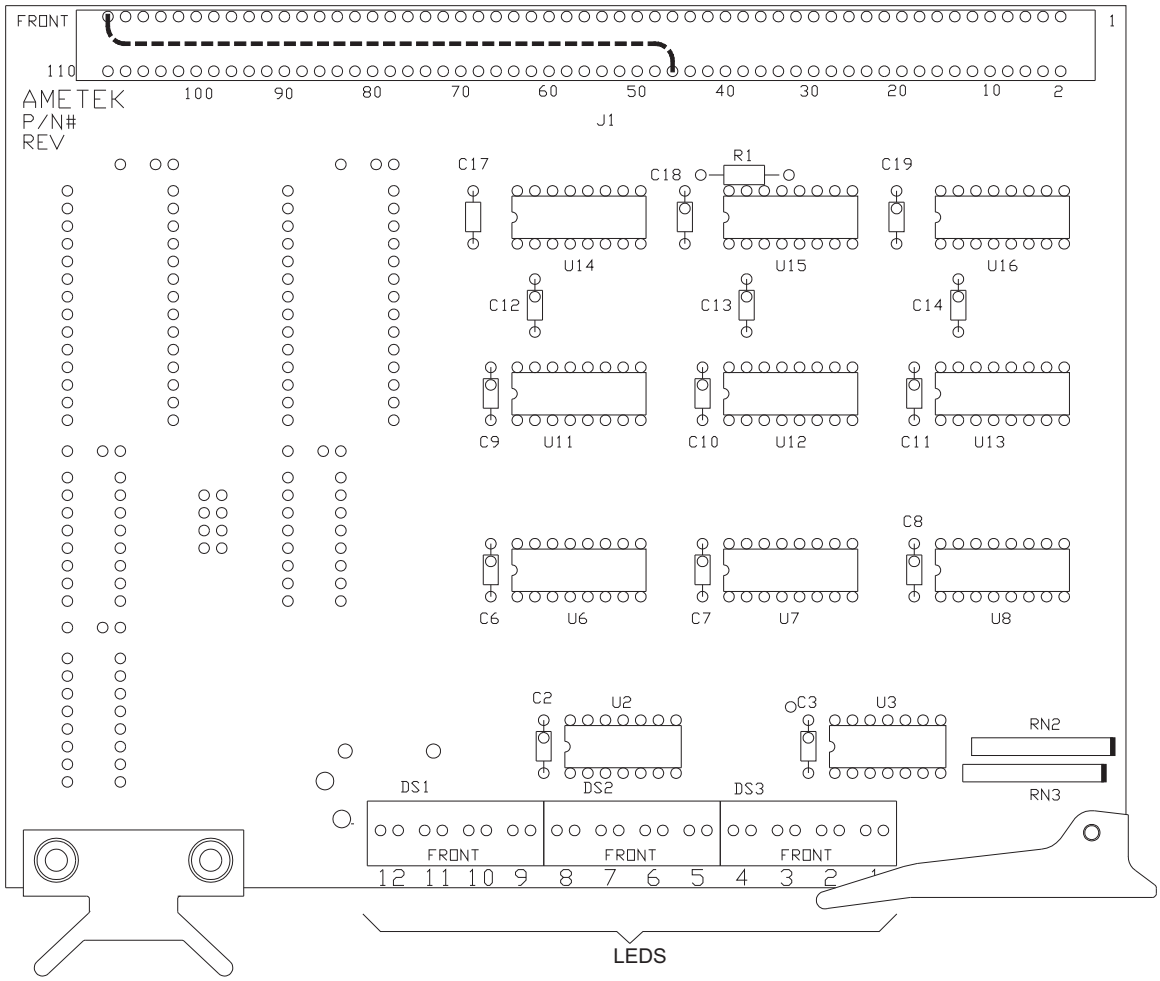

Figure 7-5.
Relay PC board.

CARD	CHANNEL	RANGE	LOCATION	DESCRIPTION
		FREQUENCY INPUTS		
Main	SPI1	500-3500 Hz	TB6-1,2	Freq 1
Main	SPI2	500-3500 Hz	TB6-3,4	Freq 2
		ANALOG INPUTS		
Main	Ch-1(cell)	-2.5 to +2.5 VDC	TB3-1,2	Alarm1 (Cell Temp)
Main	Ch-2 (M.G.)	-2.5 to +2.5 VDC	TB3-3,4	Alarm2 (M.G. Temp)
Main	Ch-3 (AIN3)	-5 to +5 VDC	TB3-5,6	Pressure (4-20 mA)
Main	Ch-4 (AIN4)	-5 to 5 VDC	TB4-1,2	Temperature (4-20 mA)
Main	Ch-5 (AIN5)	-5 to 5 VDC	TB4-3, 4	Flow (4-20 mA)
		4-20 mA OUTPUTS		
Main	Iout1	0-20 mA	TB7-1,3	4-20 mA Output1
Main	Iout2	0-20 mA	TB7-2,	4-20 mA Output2
Dual output card	Iout3	0-20 mA	TB7-4,6	Optional Output3
Dual output card	Iout4	0-20 mA	TB7-5,6	Optional Output4
		SERIAL PORT CONNECTIONS		
Main	4WTX+/2W+	RS-485		
Main	4WTX-/2W	RS-485		
Main	4WRX+	RS-485		
Main	4RX-	RS-485		
		ALARMS		
Main (K1)	Alarm1	0-32 VDC	TB8-1,2	COP Reset
Main (K2)	Alarm2	0-32 VDC	TB8-3,4	System Alarm
Main (K3)	Alarm3	0-32 VDC	TB8-5,6	Range ID
Main (K4)	Alarm6	0-32 VDC	TB8-7,8	Concentration Alarm
		RELAY OUTPUTS		
Backplane PC Assy	Relay1	115/240 VAC	TB9-1	Sample1 Not Used
Backplane PC Assy	Relay2	115/240 VAC	TB9-2	Sample2 Not Used
Backplane PC Assy	Relay3	115/240 VAC	TB9-3	Sample3 Not Used
Backplane PC Assy	Relay4	115/240 VAC	TB9-4	Sample4 Not Used
Main	K1	5 VDC	TB10-1	Sample/Reference
Main	K2	5 VDC	TB10-2	Moisture Generator
Main	K3	5 VDC	TB10-3	Sample/Reference #2
Main	K4	5 VDC	TB10-4	Moisture Generator #2
Main		0 V	TB10-5,6	Common

Figure 7-6.
5000 Input / Output.

Insert from the schematics file 11x17 fold out page.

Figure 7-7:
80498SE Wiring Module
Schematic, sheet 1 of 2

Insert from the schematics file 11x17 fold out pages.

Figure 7-8.
80498SE wiring module schematic, sheet 2 of 2.

Insert from the schematics file 11x17 fold out pages.

Figure 7-9.
80499SE relay driver schematic.

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SERIAL COMMUNICATION

The 5000 Controller is equipped with an RS-485 serial interface port that allows the analyzer to be PC-driven and makes networking up to 32 analyzers possible. AMETALK', a software package developed specifically for use with AMETEK controllers, is now available. Please contact the nearest regional sales office for more information about AMETALK'.

Hardware Requirements

An RS-485-to-RS-232 converter may be required depending on the PC configuration. AMETEK RS-485/RS-232 adapter part number 265858005 includes a special circuit which disables the transmitter when the analyzer is idle— a necessity for two-wire networks. This special adapter also requires a line power supply, P/N 265858007 (120V, only) or 269128002 (230 V, universal).

The RS232-to-RS485 adaptor and power supply (if provided) are not suitable for use in explosive atmospheres. They must be located in a safe area. Any cabling, to or from the adaptor, that passes into a potentially explosive area must be treated as incendive and protected by metallic conduit or other means consistent with local electrical codes for hazardous locations.

Wiring Configuration & Baud Rate

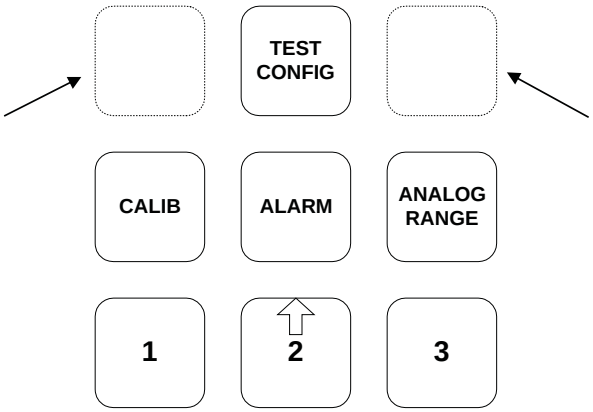
Network configuration may be two- or four-wire mode at 300 to 9600 baud/second. Refer to figures A-1a and A-1b for wiring diagrams. The controller CPU board is factory-configured for four-wire mode. All dip switches on S1 are in the up position (on). To change to two-wire operation, some dip switches on S1 should be changed to the down position (off) as shown on figure A-1b.

When configuring the analyzer software for serial communication, the value entered in the **Configure Menu** as **RS485_Baud** must also take the wiring into account. Refer to the following table for correct baud rate values.

RS485_Baud Values		
Baud Rate	**4-Wire**	**2-Wire**
9600	0	10
4800	1	11
2400	2	12
1200	3	13
600	4	14
300	5	15

NOTE

System must be reset after changing baud rate. Cycle power or reboot by simultaneously pressing hidden buttons as indicated.



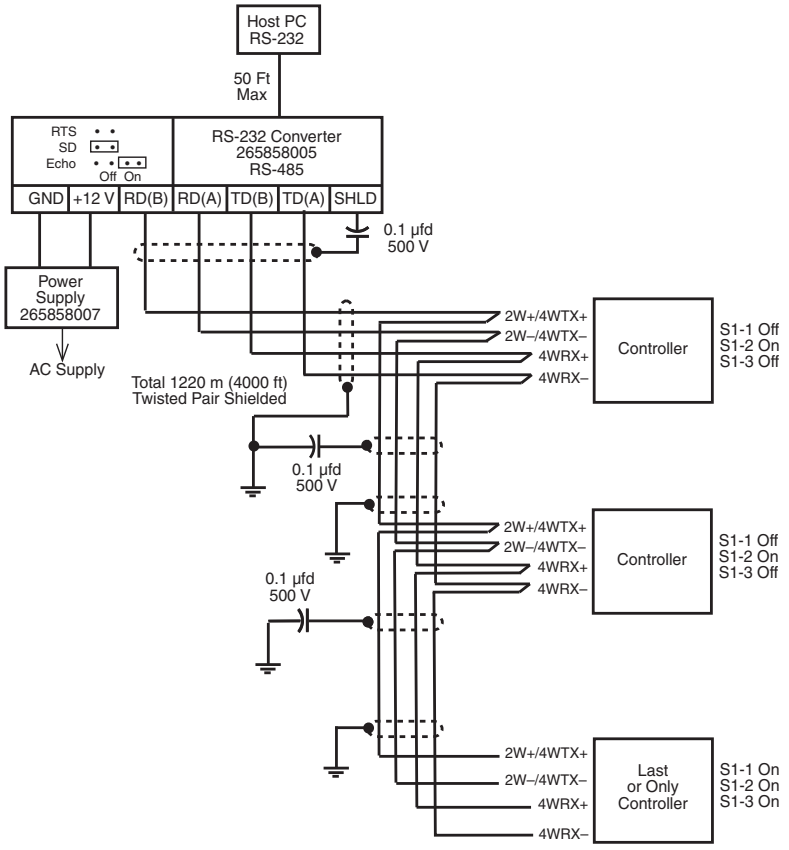


Figure A-1a.
Four-wire serial communication wiring.

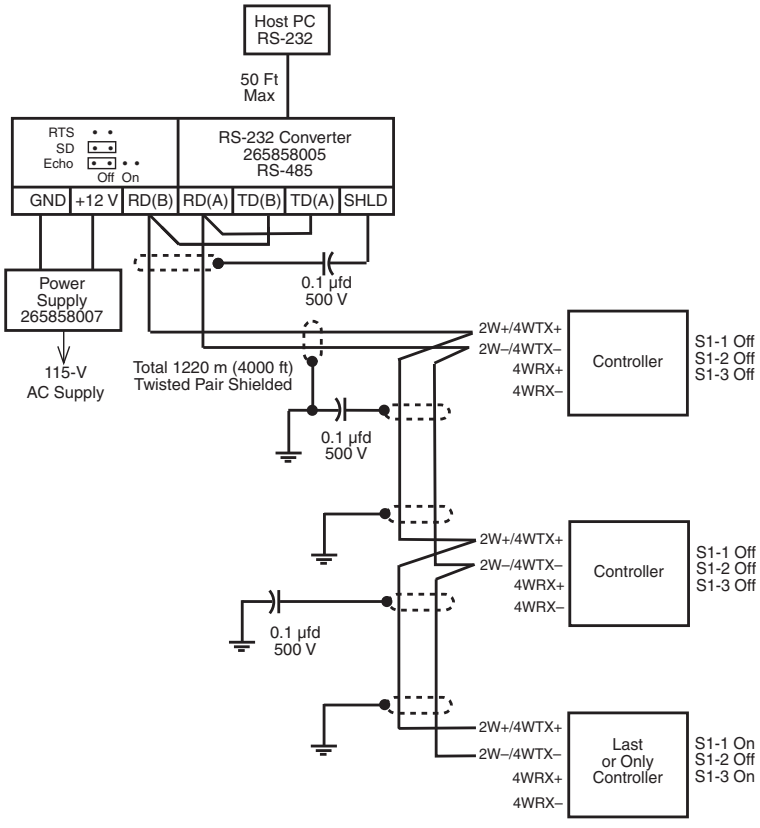


Figure A-1b.
Two-wire serial communication wiring.

Read and Write Protocol

For a single controller, the serial address (**RS485_Address**) is 200. For networked controllers, addresses from 201 to 232 are used. When multiple analyzers are networked, the address of a specific analyzer must precede the first of a string of read/write commands destined for that analyzer.

- Press and hold the **[ALT]** key while entering the 3-digit serial address. If there is doubt about which of the networked controllers is on line at a given time, type **[WHO]** and the active controller will respond with its serial address.

Read Commands

Read commands consist of the letter R (upper or lower case) followed by the two-character alphanumeric ID code for the system value. Refer to Figure A-2 for Read Only variables and ID Codes.

Example:
To read the current value of cell frequency (Cell_Freq) from analyzer 201, the command would be:

[ALT]+[2] [0] [1] followed by **R03**

Write Commands

Write commands consist of the letter W (upper or lower case) followed by the two-character alphanumeric ID code for the variable and the data to be written to the EPROM. The data field has a floating decimal format and must not exceed eight characters; plus and minus signs and trailing zeros are permitted but not required. Valid data values range from -0.00001 to +999999. Refer to Figure A-2 for Read and Write variables and ID Codes.

Example:
To write a new value of 2.5 to **Max_Span** on analyzer 201, the command would be:

[ALT]+[2] [0] [1] followed by **W342.5**.

Real Time System Values

System Value	Serial ID	Description
Moisture	01	Current Moisture Held During Equil and verification
Flow	07	NOT USED
Current_ppm	02	Current Live Moisture Including Equil and verification
Pressure	05	External Pressure For Dew Point
Temp	06	NOT USED
Cell_Freq	03	Current Cell Frequency (Hz)
Delta_Freq	04	Current Delta Frequency (Hz)
Cal_Err	09	Current Calibration Error (if error condition exists)

Countdown Timers

System Value	Serial ID	Description
Cal_tmr	10	Seconds remaining in verfication cycle
Per_Tmr	11	Seconds remaining in current period
Stable_tmr	12	Stable cycles remaining in verfication
Equil_tmr	13	Cycles remaining until tracking resumes
CurAutoCal	14	Days remaining until next auto-cal cycle

Figure A-2.
Read-Only system values.

Read and Write System Values

Constants and Polynomial Coefficients

System Value	Serial ID	Description	Path
Moist_Span	08	Cell Calibration Factor	TEST/CONFIG→Level 3 Configure Menu→Constants
Moist_Gen	20	Moisture Generator Value	TEST/CONFIG→Level 2 Configure Menu→Moist_Gen
Press_Span	21	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Press_Offset	22	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Normal_Press	23	Pressure Used for Cell Calibration	TEST/CONFIG→Level 3 Configure Menu→Constants
Temp_Span	24	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Temp_Offset	25	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Flow_Span	26	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Flow_Offset	27	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Constants
Convr_Factor	28	Used to Convert ppmv to ppbv or lb/MMscf	TEST/CONFIG→Level 3 Configure Menu→Constants
PolyCoeff_0	S0	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_1	S1	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_2	S2	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_3	S3	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_4	S4	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_5	S5	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_A	SA	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_B	SB	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_C	SC	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef
PolyCoeff_D	SD	Calibration Value for Calculating Moisture	TEST/CONFIG→Level 3 Configure Menu→PolyCoef

Alarm Levels, Noise Factors, and Range Limits

System Value	Serial ID	Description	Path
Alarm_1_Hi	29	Upper Level of Concentration Alarm 1	ALARM→Alter Alarm Levels
Alarm_2_Hi	30	Upper Level of Concentration Alarm 2	ALARM→Alter Alarm Levels
Alarm_1_Low	31	Lower Level of Concentration Alarm 1	ALARM→Alter Alarm Levels
Alarm_2_Low	32	Upper Level of Concentration Alarm 2	ALARM→Alter Alarm Levels
Max_Cal_Error	33	Max deviation between new and existing span	ALARM→Alter Alarm Levels
Max_Span	34	Max allowable cell span (Moist_Span)	ALARM→Alter Alarm Levels
Max_CD	35	Max allowable Coefficient D (PolyCoeff_D)	ALARM→Alter Alarm Levels
Freq_Noise	36	Multiplier for Infinite Impulse Noise Smoothing	TEST/CONFIG→Level 2 Configure Menu→Noise
Press_Noise	37	Multiplier for Infinite Impulse Noise Smoothing	TEST/CONFIG→Level 2 Configure Menu→Noise
Temp_Noise	38	Multiplier for Infinite Impulse Noise Smoothing	TEST/CONFIG→Level 2 Configure Menu→Noise
FlowNoise	39	Multiplier for Infinite Impulse Noise Smoothing	TEST/CONFIG→Level 2 Configure Menu→Noise
Output_1_Low	40	20 mA value of analog out 1 low range	ANALOG RANGE→Alter RangeLimits
Output_1_Hi	41	20 mA value of analog out 1 high range	ANALOG RANGE→Alter RangeLimits
Output_2	42	20 mA value of analog out 2	ANALOG RANGE→Alter RangeLimits
Offset_1_Low	43	4 mA value of analog out 1 low range	ANALOG RANGE→Alter RangeLimits
Offset_1_Hi	44	4 mA value of analog out 1 high range	ANALOG RANGE→Alter RangeLimits
Offset_2	45	4 mA value of analog out 2	ANALOG RANGE→Alter RangeLimits
Dry_CF	46	Dry Cell Frequency	TEST/CONFIG→Level 2 Configure Menu→Constants
Cell_SN	47	Cell Serial Number	TEST/CONFIG→Level 2 Configure Menu→Constants
MoistGen_SN	48	Moisture Generator Serial Number	TEST/CONFIG→Level 2 Configure Menu→Constants

Read and Write System Values (continued)

Timers

System Value	Serial ID	Description	Path
Cal_Time	C1	Time of day for auto-cal	TEST/CONFIG→SetAutoCalTime
Cal_Timer	C2	Seconds between cal cycles	TEST/CONFIG→Level 2 Configure Menu→Timing
Cal_Cycles	C3	Complete cycles to remain in calibration mode	TEST/CONFIG→Level 2 Configure Menu→Timing
Equil_Cycles	C4	Complete cycles to allow for equilibration	TEST/CONFIG→Level 2 Configure Menu→Timing
Avg_Cycles	C5	Complete cycles for Box Car Average	TEST/CONFIG→Level 2 Configure Menu→Timing
AutoCalCycle	C6	Days between auto-cal cycles; used with Cal_Time	TEST/CONFIG→Level 2 Configure Menu→Timing
Prg_Ref_Tmr	PR	Duration of reference measurement period	TEST/CONFIG→Level 3 Configure Menu→Timers
Prg_Meas_Tmr	PM	Duration of sample measurement period	TEST/CONFIG→Level 3 Configure Menu→Timers
Real Time	T1	Time of Day	TEST/CONFIG→Time of Day

Read and Write System Values (continued)

Configuration, Display, Alarm, and Output Flags

System Value	Serial ID	Description	Path
Flags_1	F1	Binary value for 1st set of configuration flags	TEST/CONFIG→Level 2 Configure Menu→Flags1
Flags_2	F2	Binary value for 2nd set of configuration flags	TEST/CONFIG→Level 3 Configure Menu→Flags2
Line_1_Flag	F3	Display flag for first line of display	TEST/CONFIG→Level 2 Configure Menu→Display
Line_2_Flag	F4	Display flag for second line of display	TEST/CONFIG→Level 2 Configure Menu→Display
Line_3_Flag	F5	Display flag for third line of display	TEST/CONFIG→Level 2 Configure Menu→Display
Alarm_1_Flag	F6	Alarm Flag for first parameter linked to system alarm	TEST/CONFIG→Level 2 Configure Menu→Alarms
Alarm_2_Flag	F7	Alarm Flag for second parameter linked to system alarm	TEST/CONFIG→Level 2 Configure Menu→Alarms
Output1_Flag	F8	Analog Flag for parameter linked to analog out 1	TEST/CONFIG→Level 2 Configure Menu→Analog
Output2_Flag	F9	Analog Flag for parameter linked to analog out 2	TEST/CONFIG→Level 2 Configure Menu→Analog

Labels

System Value	Serial ID	Description	Path
Moist_Label	L1	Held Moisture Label	TEST/CONFIG→Level 3 Configure Menu→Labels
Press_Label	L2	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Labels
Temp_Label	L3	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Labels
Flow_Label	L4	NOT USED	TEST/CONFIG→Level 3 Configure Menu→Labels
Current_Label	L5	Live Moisture Label	TEST/CONFIG→Level 3 Configure Menu→Labels
MstGen_Label	L6	Moisture Generator Label	TEST/CONFIG→Level 3 Configure Menu→Labels

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MISCELLANEOUS OPTIONS

Asymmetric Cycle 5000 Moisture Analyzer

This option minimizes effects of dirty sample streams on detector life. The basic manual describes the standard version. This appendix covers the differences between the standard and asymmetric cycle options versions.

Function	Asymmetric Cycle	Standard
Cycle (Gas flow through the moisture cell)	0.5 min wet sample/9.5 min dry reference	0.5 min wet sample/0.5 min dry reference
Reference gas conditioning	3A molecular sieve dryer, plus activated charcoal contaminant trap (recommended)	3A molecular sieve dryer

Figure B-1. Asymmetric vs. Standard timing, 5000 analyzer.

The primary cause of 5000 sensitivity loss is contaminant build-up on the crystal detector in the moisture cell. Anything done to minimize detector exposure to the contaminant or to remove the contaminant from the crystal will improve service life. The asymmetric cycle option minimizes exposure to a dirty sample and removes volatile contaminants from the crystal.

The exposure reduction is obvious (see Figure B-1). The standard cycle detector is exposed to the sample for 5 minutes out of each 10, whereas the asymmetric cycle detector is exposed for only 0.5 minute out of 10, resulting in a 90 percent time reduction in exposure to contaminants, assuming that the reference gas is clean. The reference gas can be cleaned either by using a separate known clean gas or by removing the contaminants from that portion of the sample gas used as a reference. The latter is the method most often used and is done by placing an activated charcoal contaminant trap ahead of the reference gas dryer.

Passing the clean, dry reference gas through the detector cell for the extended 9.5-minute interval helps remove volatile contaminants in preparation for the next 0.5-minute exposure to contaminated wet sample gas.

Acid Gas 5000 Moisture Analyzer

This option is offered in acid gas streams and performs as a scrubber for the internal housing of the field unit, for example, natural gas containing up to 30 percent H_2S. The basic manual describes the standard version. This appendix covers the difference between the standard and acid gas option versions.

Function	Acid Gas Option	Standard
Moisture cell	Preconditioned to H2S	No preconditioning
Oven cover	Mounts a charcoal scrubber cartridge and an air circulating fan to remove any free H2S inside field unit.	No fan or canister

Listed below are major replaceable parts for this option. Parts are shown on Figure B-2 and are located inside the field unit.

Find Number	Part Number	Description
B1	264378001	Fan Assy
F1	264377001	Replacement Scrubber Cartridge

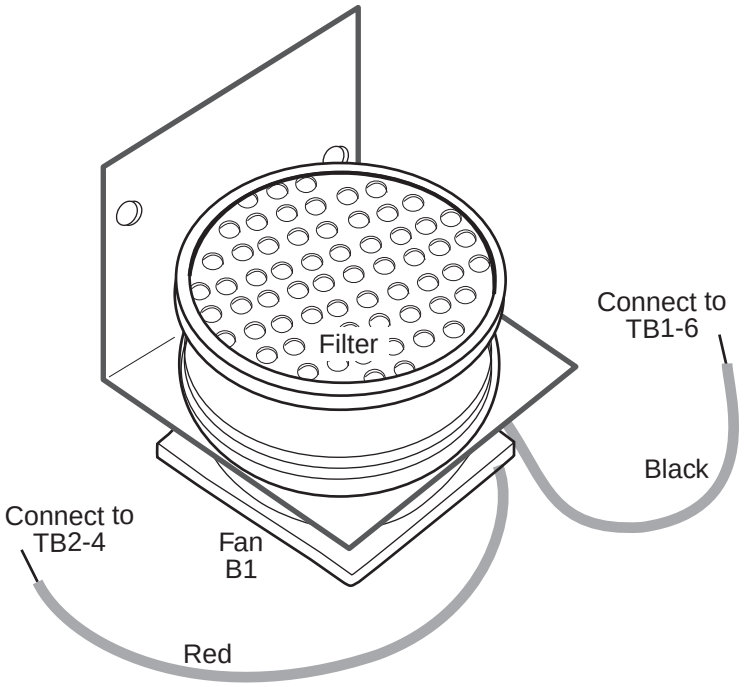

Figure B-2.
5000 Acid Gas option.

Configuring for Moisture Output in lb/MMscf

The 5000 Analyzer can convert moisture concentration in parts-per-million volume to pounds-of-water-per-million cubic feet of sample, a unit of measure commonly used in the natural gas industry. The relationship between PPMV and lbs/MMscf at 15.5 °C (60 °F) and 100 kPa absolute (14.7 PSIA) is:

1 lb/MMscf = 21 PPMV

Convr_factor = 0.0476 PPMV for MMscf reading

The 5000 Analyzer is programmed to calculate moisture concentration in PPMV or PPBV. The following procedure is used to configure the analyzer to convert output from PPMV or PPBV to lbs/MMscf and the analog outputs and the analyzer display.

1. The factory set system values for conversion factor (**Convr_Factor**) and stored moisture generator (**Moist_Gen**) must be multiplied by the above conversion factor. If the analyzer was calibrated in PPMV, these system values must be multiplied by 0.0476.

   - Refer to Chapter 5, **Moist_Gen,** to change **Moist_Gen** to the new value.

   - Refer to Chapter 5, Constants, to change **Convr_Factor** to the new value.

2. Refer to Chapter 5, Display Flags, to set the flag for display line 1, 2, or 3 to either **Held Moisture** (Flag = 1) or **Live Moisture** (Flag = 9). Refer to Chapter 5, Labels, to change the display line format as follows:

   If display flag is **Held Moisture** (Flag = 1), change display label

   from: ~~~~ PPMVol H_2O

   to: ~~~~~ H_2O lb/MMscf (for example)

   Alter **Moist Gen Label** (displayed on Line 1 when moisture generator gas flows during cal)

   Default: ~~~~~ Moist Gen PPM

3. Reprogram all Alarm and Output ranges to reflect lb/MMscf ranges.

Procedure for Using Bubble-O-Meter®

The Bubble-O-Meter is used to calibrate the flow rate of the gas through the system. Proceed as follows:

1. Wet the entire inside of the Bubble-O-Meter (tube) with a dilute liquid detergent or shampoo solution through the top of the tube.

2. Tilt the tube sideways and turn it to wet the entire inside surface.

3. Hold the tube upright and check that the liquid level in the rubber bulb is slightly below the Y arm. If level is too high, bubbles will flow without squeezing the bulb. Pour out some of the liquid if this happens.

4. Connect the bottom Y inlet port to a gas source with rubber or plastic tubing.

5. Measure the gas flow rate by carefully squeezing the bulb to form a single bubble and, with a stopwatch, time its transit time between two adjacent calibration marks.


NOTE

When making precision measurements, use the gas law equations to correct for ambient temperature and vapor pressure, and water tension above the soap solution. Be sure to add distilled water occasionally to compensate for evaporation.


NOTE

When making measurements at low flow rates with gases like helium or hydrogen, form several films ahead of the one being timed to prevent gas loss by diffusion through the film.

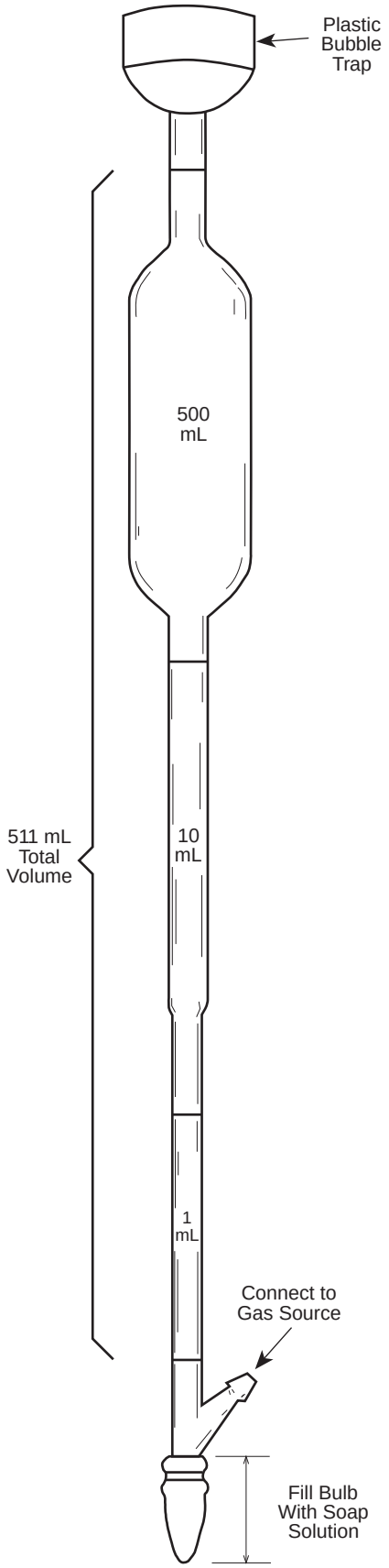

Figure B-3.
Bubble-O-Meter®

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CONVERSION FACTORS

Conversion of Water Vapor Pressure Values

This section provides information on the conversion of water vapor pressure values to more commonly used terms, such as parts per million by volume, dew point, mg/L, and lb/mmft^3.

Water Vapor Pressure and Temperature

Most tables used to express the concentration of water vapor are based on vapor pressure data of liquid water and ice. The concentration of water vapor above the liquid or solid is known as the water vapor pressure. Tables expressing the vapor pressure above ice and water at various temperatures can be found in the International Critical Tables, chemical handbooks, or other engineering handbooks.

$$\text{parts per million by volume} = \frac{\text{water partial pressure (Pv) psia @ temperature}}{\text{total pressure (Pt) psia}} \times 10^6$$

At saturation pressures above 301 kPa absolute (45 PSIA), nonideal gas corrections are required.

Temp °C	0	1	2	3	4	5	6	7	8	9
–70	0.0019	------	------	------	------	------	------	------	------	------
–60	0.0080	0.0070	0.0061	0.0053	0.0046	0.0040	0.0035	0.0030	0.0026	0.0022
–50	0.0294	0.0260	0.0229	0.0202	0.0178	0.0156	0.137	.0120	0.0105	0.0092
–40	0.0964	0.0859	0.0765	0.0680	0.0605	0.0537	0.0476	0.0421	0.0373	0.0329
–30	0.2878	0.2591	0.2231	0.2094	0.1880	0.1686	0.1511	0.1352	0.1209	0.1080
–20	0.7834	0.7115	0.6456	0.5854	0.5303	0.4800	0.4341	0.3923	0.3541	0.3194
–10	1.9643	1.7979	1.6444	1.5029	1.3726	1.2525	1.1421	1.0406	0.9474	0.8618
–0	4.5802	4.2199	3.8868	3.5775	3.2907	3.0248	2.7785	2.5505	2.3395	2.1445
0	4.5802	4.924	5.921	5.682	6.098	6.541	7.012	7.513	8.045	8.610
10	9.210	9.84	10.521	11.235	11.992	12.794	13.642	14.539	15.487	16.489
20	17.548	18.665	19.844	21.087	22.398	23.780	25.235	26.767	28.380	30.076
30	31.860	33.735	35.705	37.775	39.947	42.227	44.619	47.127	49.756	52.510
40	55.396	58.417	61.580	64.889	68.350	71.968	75.751	79.703	83.830	88.140
50	92.639	97.33	102.23	107.33	112.66	118.20	123.98	130.00	136.26	142.78
60	149.57	156.62	163.96	171.59	179.52	187.75	196.31	205.19	214.41	223.98
70	233.91	244.21	254.88	265.96	277.43	289.32	301.63	314.38	327.59	341.25
80	355.40	370.03	385.16	400.81	416.99	433.71	540.99	468.84	487.28	506.32
90	525.97	546.26	567.20	588.80	611.08	634.06	657.75	682.18	707.35	733.28

Figure C-1. Saturation vapor pressure of water vapor.

Values in Figure C-1 are in millimeters of Hg with respect to water above 0 °C and with respect to ice below 0 °C. The table in Figure C-1 is reproduced from the Smithsonian Meteorological Tables.

Absolute Humidity

The absolute humidity of water vapor in air or other gases is defined as the pressure of water vapor or as the weight-per-volume of water vapor. It is expressed in various units such as grams per liter, grams per cubic foot, or millimeters of mercury pressure.

Numerical values of water vapor pressure above water and ice are slightly different if the system contains air or another gas. For this application the difference is small and can be ignored.

Relative Humidity

The relative humidity of a gas or air pressure is the ratio of the actual or measured water vapor pressure to the saturation water vapor pressure (or absolute humidity in the gas at the same temperature) expressed as a percentage:

$$RH = \frac{P_v \text{ meas} \times 100}{P_v \text{ saturated}}$$

where RH = percent relative humidity
P_v meas = water vapor pressure measured
P_v saturated = absolute water pressure at temperature

When water vapor pressure or absolute humidity is plotted against temperature, the result is a curve showing the relationship at equilibrium. If the water vapor is not in equilibrium with water or ice in the system, then the relative humidity at the particular temperature is not 100 percent.

Dry bulb temperature and wet bulb thermometers

Relative humidity must be expressed at a given temperature referred to as the dry bulb temperature, which is the temperature of the system. The dry bulb temperature sets the value of the maximum water vapor holding capacity of the gas at a given temperature. The actual amount of water vapor in the gas can be calculated from the rate of evaporation of a water-saturated wick covering a thermometer, referred to as a wet bulb thermometer. Readings of wet and dry bulbs are used to calculate relative humidity at a given temperature.

Dew Point

Dew point is the temperature at which water begins to condense out of a gas. Dew point is dependent on pressure, so pressure must be specified before conversion from dew point to other units of moisture is possible.

Figure C-2 gives approximate conversions between gas dew point temperatures (at 1030 kPa [14.7 PSI] absolute pressure) and moisture contents expressed on both weight and volume bases.

Frost Point

When the dew point is below the freezing point of liquid water, the water vapor may freeze without going through the liquid phase. A dew point below 0 °C is called from the frost point.

Volumetric Measurement

A plot of dew point and frost point versus water vapor content in parts per million by volume at 1030 kPa (14.7 PSI) absolute is shown in Figure C-3.

Conversion Table

The relationship between water vapor concentration and other conversion factors to express the concentration of water vapor in a gas is:

Parts per Million by Volume	x	Factor	=	Conversion
Parts per Million by Volume	x	8.04×10^{-4}	=	mg/L
Parts per Million by Volume	x	$\frac{18}{*M\ Wt}$	=	Parts per Million by Weight
Parts per Million by Volume	x	4.76×10^{-2}	=	$lb/mmft^3$

*M Wt = Molecular weight of sample gas

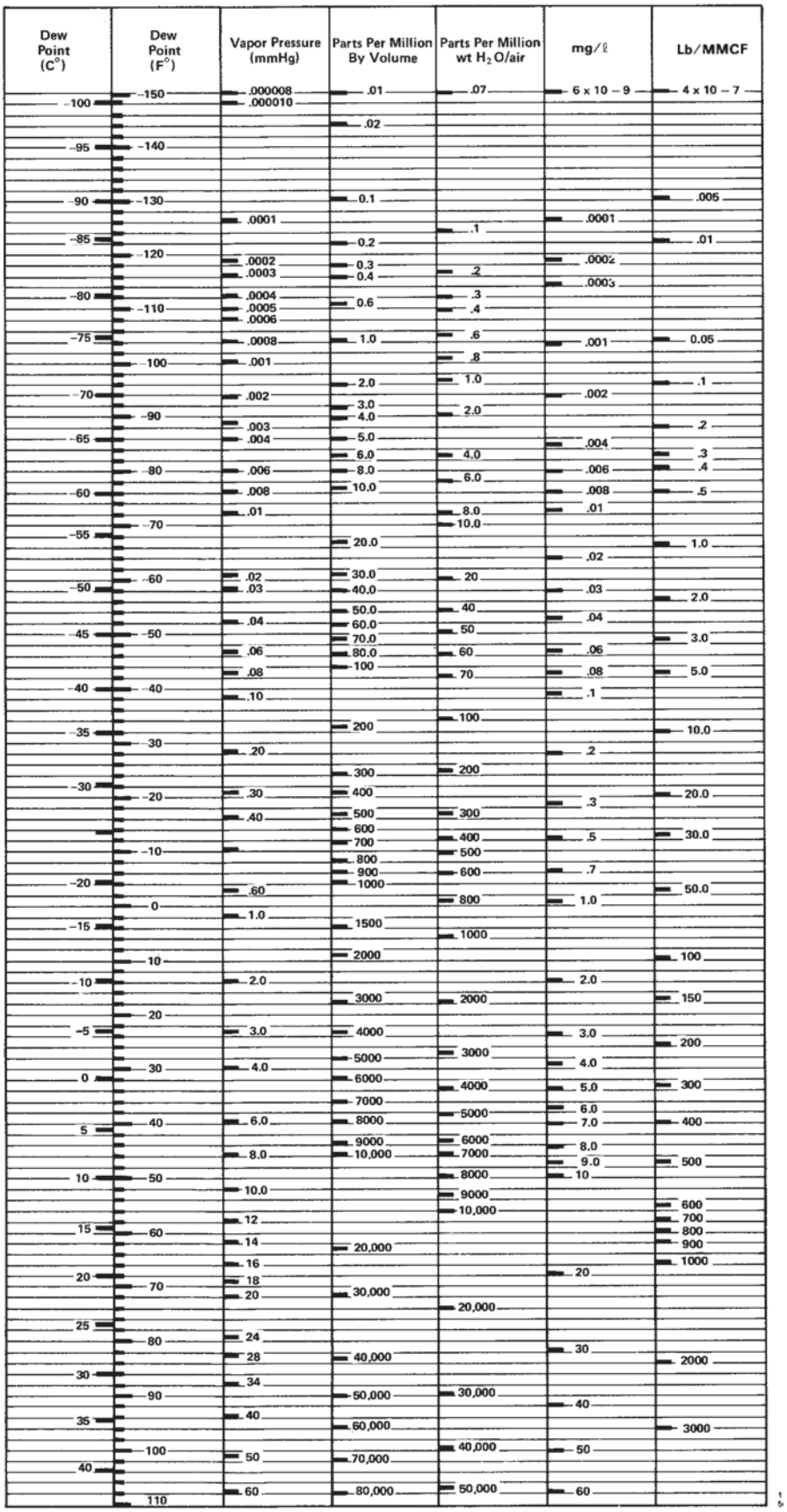

Figure C-2. Dew point temperature and moisture content by weight and volume.

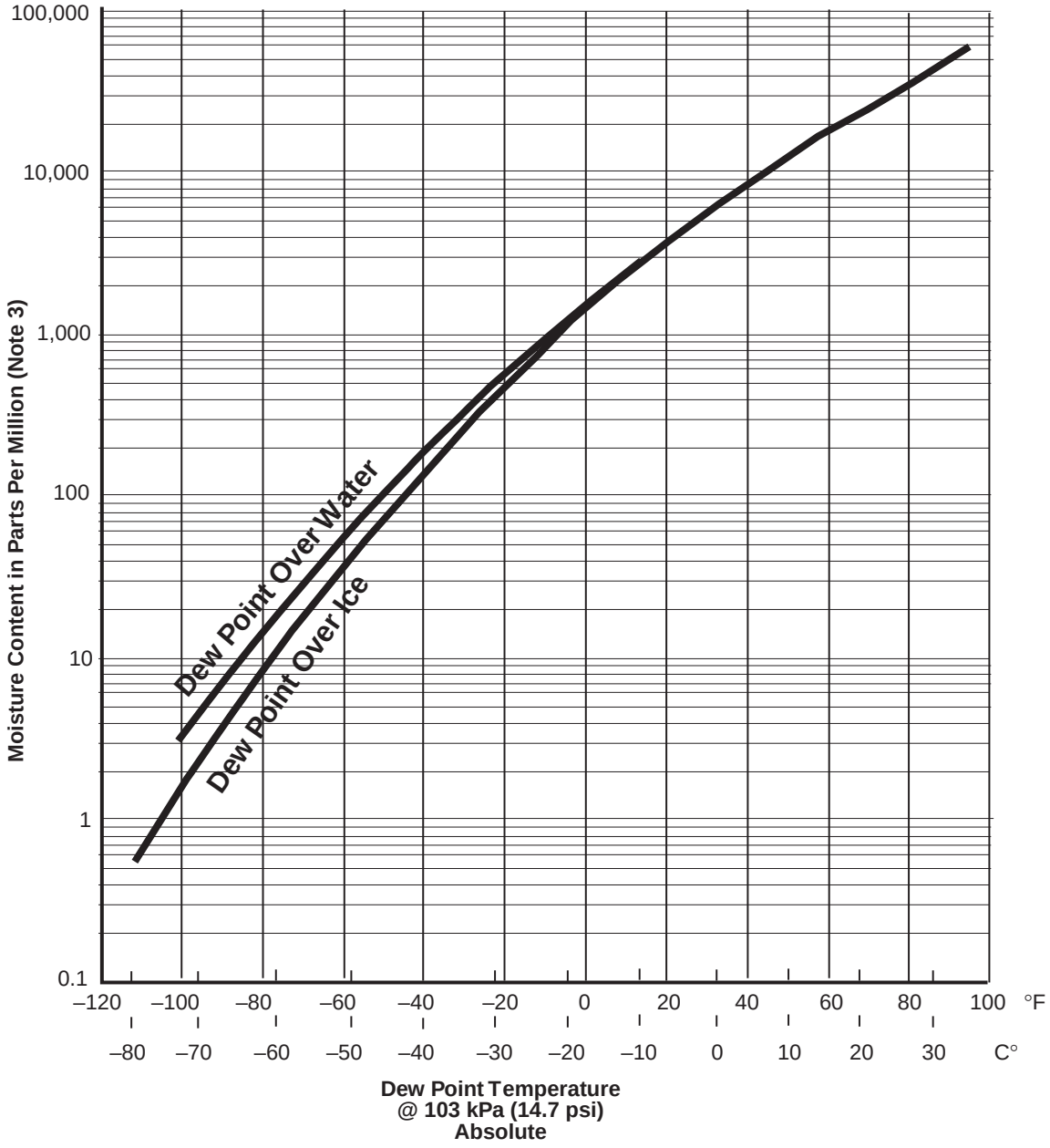

Figure C-3.
Dew point and frost point vs water vapor

Flowmeter Correction Factors

Divide the desired flow rate by the correction factors to obtain approximate flowmeter settings.

Gas	Correction Factor
Argon	0.85
Butadiene	0.883
Butane	0.853
Cracked NH_3	1.74
Carbon Monoxide	1.01
Ethane	1.11
Ethylene	1.13
Freon® 22	0.58
Freon®	0.38
Helium	1.970
Hydrogen	3.233
Isobutane	0.866
Isobutylene	0.72
Methane	1.4
Nitrogen	1.02
Oxygen	0.933
Propane	0.960
Propylene	0.83

If a more accurate flowmeter setting or a setting for a gas not listed is desired, use the Bubble-O-Meter® as detailed in Appendix B.

Interferences Caused by Gases other than Air

The system is factory-calibrated to read directly for air, oxygen, and nitrogen. The instrument will analyze moisture in hydrocarbons, refrigerants, and other various gases (some are listed in Figure C-4).

The background interference is present when the sample is a gas other than air and the reference is dry air or nitrogen. This interference is caused by the physical and chemical differences of the sample and reference gases. Of the gases in Figure C-4, only carbon dioxide causes an in-

terference which can be attributed to sample sorption on the crystal coating. Data in Figure C-3 shows typical amounts of interference between a dry sample gas and a reference gas of dry air or nitrogen.

These values are pressure-dependent. We suggest that you determine the interference for a particular sample by temporarily running the analyzer with a sample gas dried with a 3A molecular sieve or other appropriate desiccant, against a reference gas of instrument air or nitrogen passed through the 3A sieve dryer supplied. Assuming that both gases are then dry, any apparent "moisture" indicated by the analyzer will be the interference. This error can be subtracted from readings by adding the measured error to the value programmed for Poly Coeff 0.


NOTE

Interferences can be avoided by using dried sample gas as the reference.

Sample gas 100 %	Indicated ppm v/v	Vapors	% Concentration	Indicated ppm v/v
Oxygen	0.0	Heptane — air	4	10
Nitrogen	0.0	Benzene — air	9	10
Carbon Monoxide	0.7	Methanol — air	12	150
Propane	0.7	Ethanol — air	1	1
Ethane	1.3	Perchloroethylene — air	3	8
Ethylene	1.3			
Methane	1.7			
Hydrogen	2.6			
Isobutane	2.6			
Butane	2.6			
Isobutylene	5.0			
F-22	10.0			
F-12	7.5			
Carbon Dioxide	44.0			

Figure C-4: Typical interference values for gases other than air.

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MOISTURE OUTPUT IN DEW POINT (FROST POINT)

Moisture (Held) concentrations in parts-per-million volume (PPMV) can be converted to dew point. Since the dew point is directly related to the vapor pressure of the water in a gas, the pressure (absolute PSIA) of the gas must be considered in the calculation.

The following procedure is used to configure the analyzer's display, pressure input, outputs for both alarms and analog(s) from PPMVto dew point.

Refer to Chapter 5 and the Menu Map for more information on completing the steps.

STEP 1

FLAGS 2 (Refer to Chapter 5, Flags2).

Bit Value	Function
1	Output in dew point
2	Output in vapor pressure
4	Use enhanced noise smoothing
8	Pressure in bar absolute
64	Enable dew point calculation in °F

Flags 2 configuration sample: = 69 (1 + 4 + 64)

Where:
1 = Enable dew point calculations
4 = Use boxcar averaging
64 = Calculate dew point temperature in °F.


NOTE

*The analyzer will display dew point in Celsius if **Flags 2** is set to = 5.*

STEP 2

Alter **Moisture Label** for temperature in °C to change the display line format as follows:

From: ~~~~ ppm Vol H_20

To: ~~~~ Dew PT Temp °C

Change **Display Flag** value, Line 1 (Chapter 5, Display Flags) set to **Held Moisture** . . ., Flag =1

*The conversion to dew point calculations is not used in the displays or calculations for the **Moisture Generator** and **Zero** operations.*

STEP 3

PRESSURE CONSTANTS

Set NORMAL_PRESS = 0

The absolute pressure value of the sample gas must be entered, a manual or automatic method is provided, also an optional engineering unit Bar rather than PSIA can be selected. To enable from PSIA to Bar, refer to Chapter 5. Flags2, Bit 8.

Automatic

A live absolute pressure value signal, 4–20mA TB3 (refer to controller back panel connections in Chapter 3), is determined by the specific pressure transmitter, when the transmitter's minimum output is not zero. A 15VDC excitation voltage is provided for a closed-loop analog input.

Example:

Pressure Transmitter: Range = 0–30 PSIA
Output = 4–20 mA

Calculated Values: **Pressure_Span** = 1.875 = 30 / (20 - 4)
Pressure_Offset = –7.5 = 0 - 1.875 * 4

Manual

For the operating pressure, enter **Pressure_Span** and **Pressure_Offset** values either through the serial communication port or the keypad.

Pressure_Span = 0
Pressure_Offset = XX.XX

XX.XX = absolute pressure

STEP 4

ANALOG RANGE
Analog ranges must be configured for **Range** in temperature units (Celsius or Fahrenheit).

STEP 5

ALARM RANGE
Must be configured for **Range** in temperature units (Celsius or Fahrenheit).

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DETERMINATION OF OFFSET AND COEFFICIENT D ADJUSTMENT

Background

Because sample and reference gases travel different paths to the analyzer cell, they are subjected to different outgassing effects. The components they pass through outgas at constant but dissimilar rates. This results in a different amount of moisture being sorbed by the sample and reference gases and creates an offset frequency between the two gases. For low moisture concentration applications (< 1 PPM), this zero offset must be eliminated from the measured cell Dfrequency which is used to determine the moisture content of the sample gas. The correction is done by introducing the offset frequency, also known as coefficient D, into the moisture calculations. The following procedure is used to determine the values of coefficient D.


NOTE

This procedure may take over two hours to complete. Arrangements must be made for the analyzer to be off-line for the duration.

Procedure

For systems using a conditioned sample gas as reference

1. The reference gas will be used as the sample input for this procedure. To do this, configure the dry reference bypass loop as shown in Figure E-1. Close the sample shutoff valve and open the dry reference bypass valve. Some of the conditioned reference gas will be diverted to the sample input.

For systems using a separate gas source as reference

1. The sample must pass through similar conditioning components as above. Configure the dry sample bypass loop as shown in Figure E-2. Note that only a molecular sieve dryer is shown in the loop. If other components (super-activated dryer, trap) are used, these must also be in the loop. Adjust the three-way dry sample bypass valves as required to divert the sample through the loop before the sample input.

2. Verify that both sample and reference flow rates at the field unit are the same. Adjust the appropriate field unit pressure regulator as required.

3. Configure the software for this procedure. Note that the Level 3 access code is required.

    - Refer Chapter 5, Display Flags to view the current value of **Line_1_Flag**. Record this value so you can reload it when the coefficient D adjustment is complete. Change the **Line_1_Flag** value to **4** (Delta Frequency).

    - Refer to Chapter 5, **PolyCoeff_D** to view the current value of Coefficient D. Change the value of Coefficient D to 0.00.

    - Return the controller to normal operation mode by pressing **Cancel** until the normal operation screen is displayed. Display line 1 will read **~.~~~ hz Delta Freq.**

4. Wait at least 30 minutes for the reading to stabilize.

5. Paying close attention to the positive or negative sign, record the new value of coefficient D.

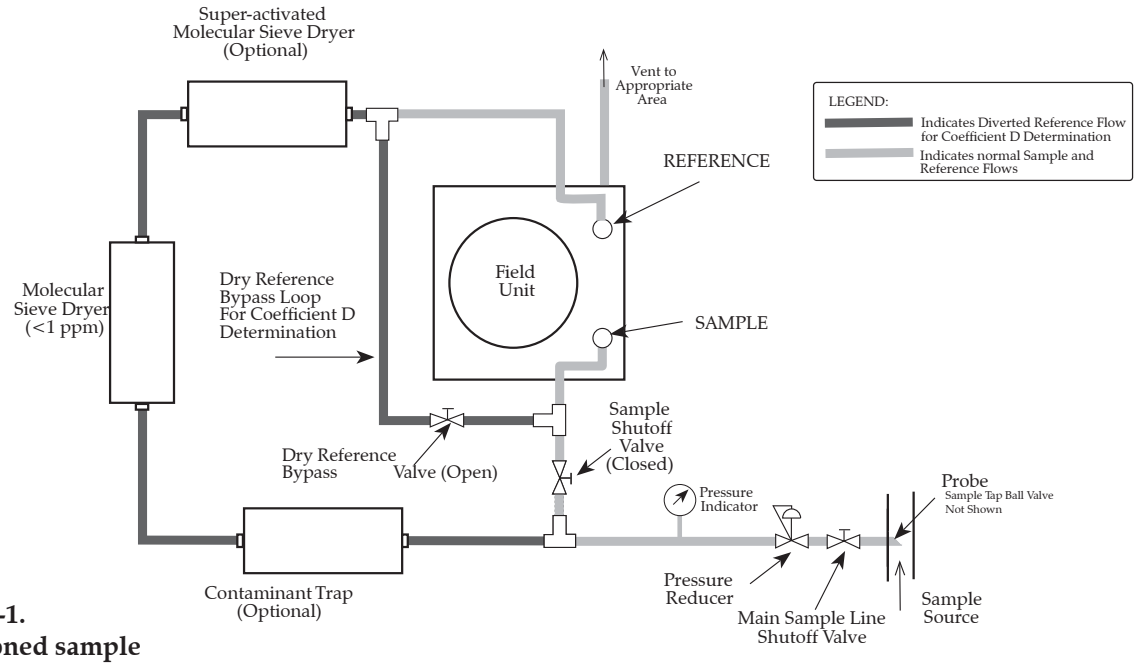


Figure E-1.
Conditioned sample gas as reference setup.

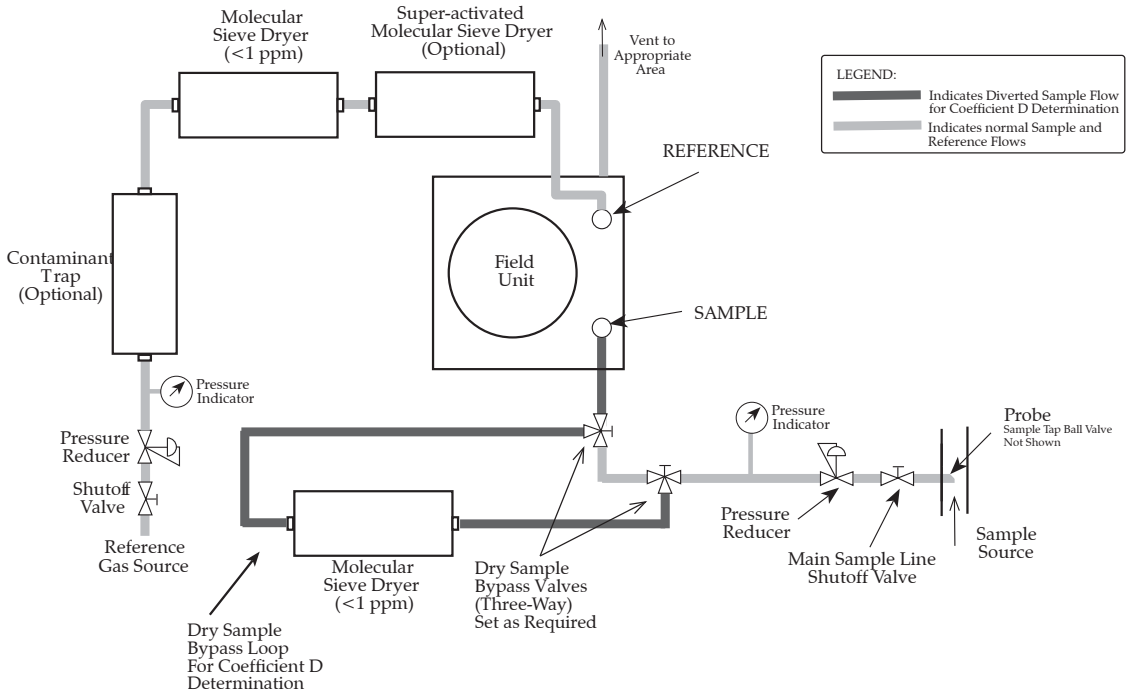


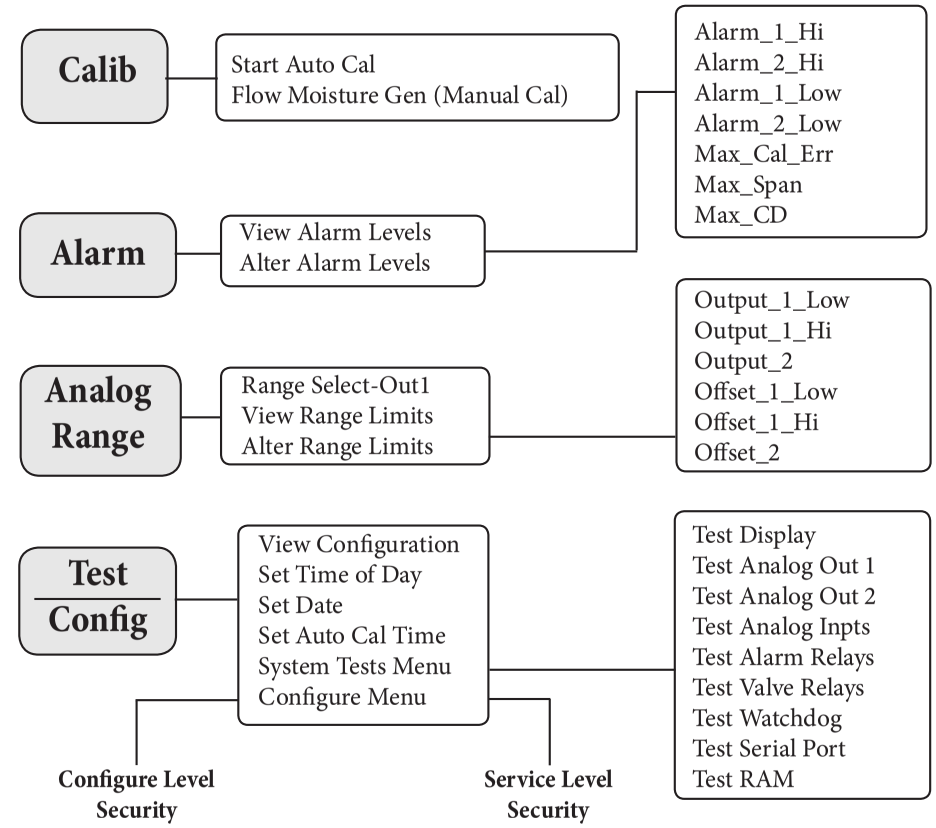
Figure E-2.
Using a separate gas source as reference.

6. Refer to Chapter 5, **PolyCoeff_D** to change the value of **PolyCoeff_D** to the new value. Enter the new coefficient value when the "New Value?" prompt is displayed. Press **Enter** to save change or press **Cancel** to quit.

When finished:

7. Return to normal operation flow by adjusting the dry reference (Figure E-1) or dry sample (Figure E-2) bypass valves as required.

8. If desired, return the value for **Line_1_Flag** to its original value as recorded in Step 3.



See Reverse Side for Configure Menu Maps

Refer to flag lists at right for input values for menu items in **bold** type.

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5000 Controller

Information contained on this sheet subject to revision.
PN 500090001 Rev C

Flags: Analog (Output 1 & 2)
Alarms (1 & 2)
Display Lines (1,2, & 3)

0	None
1	Moisture Held During Equilibration (ppm)
2	Live Moisture (ppm)
3	Cell Frequency (Hz)
4	Delta Frequency (Hz)
5	Pressure (bar or psi)
6	Temperature (C)
7	Flow (mL/min)

Display Line *ONLY* Flags

14	Alarm/Valve Signal Display
15	Timers
16	Output Range (Channel 1)

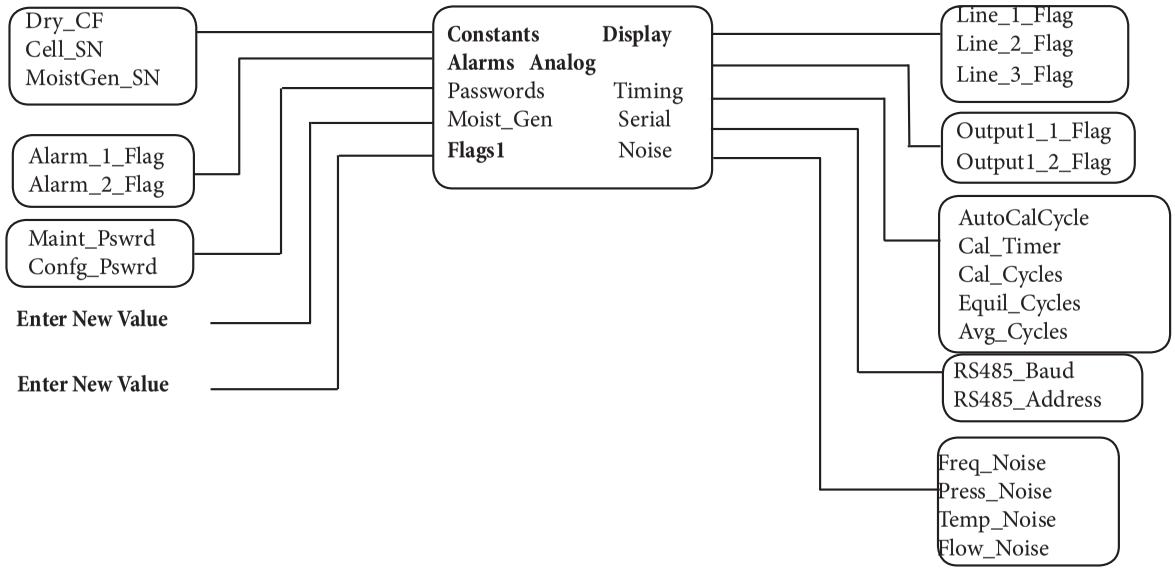
Flags1: Enter sum of flag values for functions to be enabled:

1	Auto-Range (Channel 1 Analog Ouput)
2	Use Range Alarm for Cal Alert
4	Use Concentration Alarm to Confirm Valid Signal
8	Normally Open Alarm Contacts
16	NO Span Adjustment During Auto-Cal Cycle
32	Track Outputs During Cal Cycle
64	Display Negative Moisture Value as Zero
128	Use Non-Verbose Display Mode (Line 4)

Flags2: Enter sum of flag values for functions to be enabled:

1	Ouput in Dew Point
2	Output in Vapor Pressure
4	Use Enhanced Noise Smoothing
8	Pressure in bar absolute

Level 2 Configure Menu



AMETEK

5000 Controller

Level 3 Configure Menu