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Model 5028i Instruction Manual

Continuous Particulate Monitor

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Thermo Fisher SCIENTIFIC

Model 5028*i*

Instruction Manual
Continuous Particulate Monitor
Part Number CIC0001582
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WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher Scientific's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher Scientific products which may assist the detection of substances subject to the RoHS Directive are available at: www.thermo.com/WEEERoHS.

About This Manual

This manual provides information about installing, operating, maintaining, and servicing the Model 5028i Continuous Particulate Monitor. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendices to provide direct access to specific operation and service information.

- Chapter 1 "Introduction" provides an overview of product features, describes the principle of operation, and lists the specifications.
- Chapter 2 "Installation" describes how to unpack, setup, and startup the instrument.
- Chapter 3 "Operation" describes the front panel display screens, the front panel pushbuttons, and the menu-driven firmware.
- Chapter 4 "Calibration" provides the procedures for calibrating the analyzer and describes the required equipment.
- Chapter 5 "Preventive Maintenance" provides maintenance procedures to ensure reliable and consistent instrument operation.
- Chapter 6 "Troubleshooting" presents guidelines for diagnosing analyzer failures, isolating faults, and includes recommended actions for restoring proper operation.
- Chapter 7 "Servicing" presents safety alerts for technicians working on the analyzer, step-by-step instructions for repairing and replacing components, and a replacement parts list. It also includes contact information for product support and technical information.
- Chapter 8 "System Description" describes the function and location of the system components, provides an overview of the firmware structure, and includes a description of the system electronics and input/output connections.
- Chapter 9 "Optional Equipment" describes the optional equipment that can be used with this analyzer.
- Appendix A "Warranty" is a copy of the warranty statement.
- Appendix B "C-Link Protocol Commands" provides a description of the C-Link protocol commands that can be used to remotely control an analyzer using a host device such as a PC or datalogger.

- Appendix C "MODBUS Protocol" provides a description of the MODBUS Protocol Interface and is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.
- Appendix D "Gesytec (Bayern-Hessen) Protocol" provides a description of the Gesytec (Bayern-Hessen or BH) Protocol Interface and is supported both over RS-232/485 as well as TCP/IP over Ethernet.
- Appendix E "ESM Protocol Commands" provides a description of the ESM Protocol commands (from the prior FH62 platform) that can be used to remotely control an analyzer using a host device such as a PC or datalogger.

Safety

Review the following safety information carefully before using the analyzer. This manual provides specific information on how to operate the analyzer, however, if the analyzer is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Equipment Damage Alerts

This manual contains important information to alert you to potential safety hazards and risks of equipment damage. Refer to the following types of alerts you may see in this manual.

Safety and Equipment Damage Alert Descriptions

Alert	Description
⚠ **DANGER**	A hazard is present that could result in death or serious personal injury if the warning is ignored. ▲
⚠ **WARNING**	A hazard or unsafe practice could result in serious personal injury if the warning is ignored. ▲
⚠ **CAUTION**	A hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
⚠ **Equipment Damage**	A hazard or unsafe practice could result in property damage if the warning is ignored. ▲

Safety and Equipment Damage Alerts in this Manual

Alert	Description
⚠ **WARNING**	The Model 5028*i* is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲ If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲ The service procedures in this manual are restricted to qualified service personnel only. ▲

Alert	Description
	The detector assembly should be replaced by a qualified technician knowledgeable in dealing with radiation precautions. By removing the detector assembly, the C-14 radioactive source is partially exposed. Safety glasses must be worn during this replacement procedure. The amount of C-14 meets the USNRC regulations as an exempt amount of radioactive source <100 µCi.
⚠ **CAUTION**	The detector window is very fragile. Handle with great care and do not wipe or touch the window. Furthermore, do not touch the solder cable connection (electrode) with your bare fingers. The oils from your skin can damage the detector.
	Safety glasses must be worn while replacing the detector assembly.
	If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲
⚠ **Equipment Damage**	Do not attempt to lift the analyzer by the cover or other external fittings. ▲
	Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲
	Disconnect the serial cable before changing the RS-232 and RS-485 selection to prevent damage to any equipment currently connected to the analyzer. ▲
	Do not use solvents or other cleaning products to clean the outside case. ▲
	Do not remove the LCD panel or frame from the LCD module. ▲
	The LCD polarizing plate is very fragile, handle it carefully. ▲
	Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲
	Do not use alcohol, acetone, MEK or other ketone based or aromatic solvent to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲
	Do not place the LCD module near organic solvents or corrosive gases. ▲
	Do not shake or jolt the LCD module. ▲

Electrical/Safety Certifications

The product has been tested and has been documented to be in compliance with the following U.S. and Canadian safety standards:

UL Standard 61010-1:2012Ed.3+ R:15 Jul 2015
CSA C22.2 No.61010-1:2012 Ed.3+G1
IEC 61010-1:2010 (Third Edition)
IEC 61010-2-081: 2015 (Second Edition)

Thermo Fisher Scientific certifies that this product operates in compliance with the EC Directive 89/336/EEC in reference to electrical emissions and immunity. Specifically, the equipment meets the requirements of EN 61326-1:1998 for Immunity and Emissions. In addition, the hardware has been tested for personal or fire safety hazards in accordance with EN61010-1:2001 (Safety) in fulfillment of EC Directive 73/23/EEC.

FEM Statement

Model 5028i Continuous Particulate Monitor for PM10 *Automated Equivalent Method***: EQPM-1102-150; for PM2.5** *Automated Equivalent Method***: EQPM-0609-183.**

"Model 5028i Continuous Particulate Monitor" configured with two 10 micron size selective inlets, one PM2.5 BGI Inc. Very Sharp Cut Cyclone (VSCC™) particle size separator and DHS, operated with a total actual flow of 16.67 L/min for each channel. and according to the Thermo Scientific 5028*i* Continuous Ambient Particulate Monitor operating manual.

FCC Compliance

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note This equipment has been tested and found to comply within the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense. ▲

WEEE Symbol

The following symbol and description identify the WEEE marking used on the instrument and in the associated documentation.

Symbol	Description
	Marking of electrical and electronic equipment which applies to waste electrical and electronic equipment falling under the Directive 2002/96/EC (WEEE) and the equipment that has been put on the market after 13 August 2005. ▲

Where to Get Help

Service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.Thermofisher.com

1-866-282-0430 Toll Free

1-508-520-0430 International

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Chapter 1
Introduction

The Model 5028i Continuous Particulate Monitor continuously measures two mass concentration of suspended and refined particulates (e.g., TSP, PM_{10}, $PM_{2.5}$, and PM_1) simultaneously by the use of beta attenuation. In addition, the influence of natural Radon (Rn-222) gas is corrected for as a mass refinement step allowing better sensitivity at lower ambient particulate concentrations.

In contrast to other beta attenuation monitors using Carbon-14 (C-14) as a source of the beta rays, the Model 5028*i* particulate sample collection area is located between both the C-14 source and the proportional counter. While ambient particulate is being deposited onto a filter tape sample spot, the dynamic filter loading is measured simultaneously by the attenuation of the C-14 source beta rays. As a result of this configuration, a continuous real-time measurement of airborne particulate is provided. It is not necessary to move the filter spot from the sample position to a separate detector position for zero and mass determinations (old step-wise method of beta attenuation monitors). Therefore, uncertainties associated with step-wise filter transport are eliminated by the use of this continuous ambient particulate monitoring method.

The Model 5028*i* takes into consideration background interferences with known beta attenuation methods. When present, the daughter nuclides of the natural noble gas Radon (Rn-222) attach to airborne particulates, which are then collected on the sample filter during mass measurement. Some of the radioactive daughter nuclides are also an emitter of beta rays interfering with the measurement of the particulate mass. The effect of the interference is generally greatest during:

- The first 90 minutes after a filter change until the radiological equilibrium on the filter is reached
- Periods of rapidly changing Radon gas levels
- When the activity of the C-14 source is very low

In the Model 5028*i*, a discrimination technique is applied whereby the count rate created by the airborne natural activity is measured and corrected for in the gross particulate count rate. This eliminates any interference and enables the possibility to use a C-14 source with reduced activity. The ability to count the potential interferences of Radon gas stems from the use of a proportional detector, which enables the Model 5028*i* to measure both α and β particles. The proportional detector is filled with a rigid counting gas and has a life-time of more than 10 years with a <100 µCi C-14 source. Any deterioration of the detector performance will be identified before it has an effect on the particulate measurement by the continuous plateau check procedure performed during operation.

Another unique design of the Model 5028*i* is that two measurement heads are used while Model 5014i only using one. The measurement heads can open or close separately, and measure $PM_{2.5}$ & PM_{10} simultaneously. In the measurement heads, beta ray is transmitted from the bottom upwards passing through the filter tape and the accumulated particles layer. The intensity of beta ray is attenuated by the increasing mass load, thus reducing its intensity. The reduced beta intensity is then measured by the proportional detector. The mass on the filter tape is calculated from the continuous integrated count rate. The determined count rate is continuously corrected with regard to changes in the air density.

The sample flow rate is controlled by means of two proportional solenoid valves. The two valves opening varies according to the flow rate measured across a precision orifice.

A complete Dual Channel particulate measuring assembly consists of the following main parts:

- Central Monitoring Unit (5028*i* Continuous Particulate Monitor)
- Ambient Inlet Sampling System (TSP, PM_{10}, $PM_{2.5}$, VSCC™) particle size separator)
- Dynamic Heaters
- Diaphragm Vacuum Pump
- External Ambient T/RH Sensor Assembly
- Internal Data Recording Unit and External Communication Ports
- Optional 4-Ft/6-Ft/8-Ft/10-Ft. Insulated Extension Tube(s)
- Optional Tripod Support

The Model 5028*i* combines proven technology, easy to use menu-driven firmware, and advanced diagnostics to offer unsurpassed flexibility and reliability. The Model 5028*i* has the following features:

- 320 x 240 pixels graphics display

- Menu-driven firmware
- Field programmable ranges
- Multiple user-defined analog outputs
- Analog input options
- Linearity through all ranges
- User-selectable digital input/output capabilities
- Standard communications features include RS-232/485 and Ethernet
- C-Link, MODBUS, Gesytec (Bayern-Hessen), ESM Protocol, streaming data, and NTP (Network Time Protocol) protocols. Simultaneous connections from different locations over Ethernet.
- Radon gas activity measurement (Rn-222; noble gas) and mass refinement
- Flexible data storage configurations
- Volumetric air flow rate control with actual and standard conditions concentration data output
- Processor controlled calibration of all sensors
- Detector Life ~10 years
- C-14 activity below USA authorized limit values; shipped as non-hazardous material under Code UN2911; easy handling of the source and instrument. No license is needed in most countries.

For details of the analyzer's principle of operation and product specifications, see the following topics:

- "Principle of Operation" on page 1-3
- "Specifications" on page 1-7

Thermo Fisher Scientific is pleased to supply this continuous ambient particulate monitor. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Thermo service personnel are available for assistance with any questions or problems that may arise in the use of this instrument. For more information on servicing, see the "Servicing" chapter.

Principle of Operation

The Model 5028*i* uses the radiometric principle of beta attenuation through a known area on a fibrous filter tape to continuously detect the mass of deposited ambient particles. Additionally, the Model 5028*i* measures alpha particle emissions directly from the ambient aerosol being sampled and excludes negative mass artifacts from the daughter nuclides of radon gas decay to achieve a refined mass measurement.

Simultaneous refined mass measurements of sampled particulate on the filter tape and sample volume measurement provide a continuous concentration measurement of ambient particulate concentration.

Figure 1–1 provides a schematic of the components used within the Model 5028*i*. Within the two measurement chambers the four key components are 1) the proportional detector, 2) particle collection onto a glass fiber filter tape, 3) a vertical moving vacuum chamber plate, and 4) the C-14 beta source <100 µCi (<3.7 Mbq). Based on this schematic, a description of operation is provided.

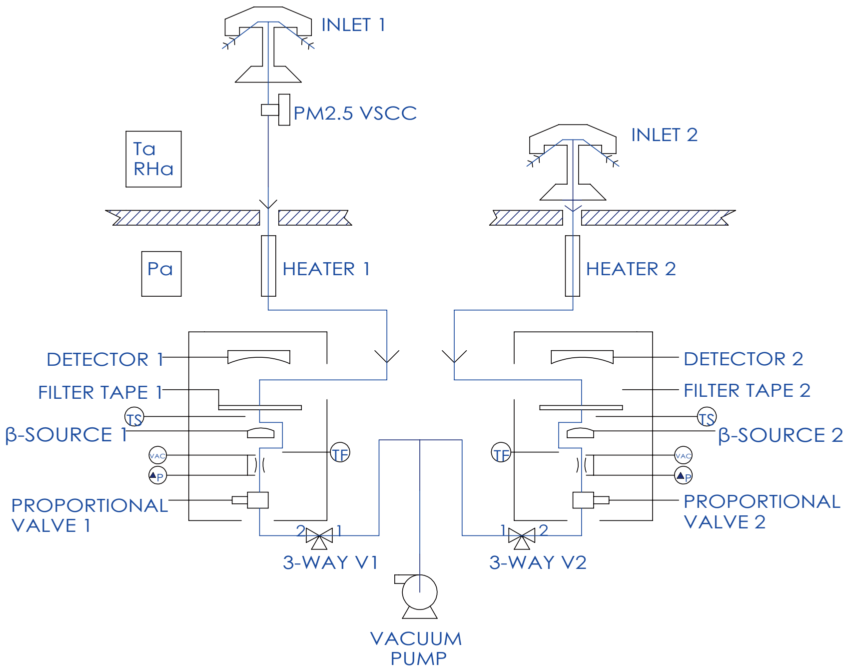


Figure 1–1. Model 5028*i* Flow Schematic

A clean filter spot is introduced by an automatic filter change to the combined sampling and detection chamber at least every 24 hours, usually centered at midnight. However, the official filter tape change frequency for U.S. EPA testing for both $PM_{2.5}$ and PM_{10} is every 8 hours. The automatic filter changes are controlled by the instrument firmware which halts the 3-way valves operation, lowers the vacuum chamber plate, advances the filter tape a fixed length, raises the vacuum chamber plate, and initiates the 3-way valve of the channel operation and a zeroing of the sample spot. Immediately after a filter change, a new measurement cycle is initiated with an automatic zero adjustment of the mass signal. The filter change interval and time of day can be user adjusted. Additionally, automatic filter changes will occur if the mass on the filter exceeds 1,500 µg since the last filter change or if the flow rate through the filter tape is reduced by more than 5% due to potentially restrictive particle deposition.

An example for sampler configuration, Channel A (Channel 1) of Model 5028*i* is used to measure $PM_{2.5}$ concentration with the specified 10-micron EPA PM_{10} inlet, ambient air is drawn into the 10 micron (µm) size selective inlet which discriminates against particles with an equivalent aerodynamic diameter above 10 µm. It has been approved previously through prior U.S. EPA designations (RFPS-0699-130, 131, and 132) and is also listed within 40 CFR Part 50, Appendix L as a 10-MICRON INLET (including model SA246b). $PM_{2.5}$ BGI Inc. Very Sharp Cut Cyclone (VSCC™) particle size separator is using for $PM_{2.5}$ selection. Meanwhile, Channel B (Channel 2) of Model 5028*i* use to measure PM_{10} concentration only with the specified 10-micron EPA PM_{10} inlet.

The volumetric flow rate at both inlet entrances are 16.67 liters per minute (1 m^3/hour). In addition, the ambient temperature and relative humidity is measured via a naturally aspirated radiation shield and standard sensor as part of the volumetric flow control and dynamic heating system.

Note Further particle discrimination would be achieved by inserting a $PM_{2.5}$ or PM_1 cyclone between the 10-micron inlet and sample tube. TSP inlets and European-style inlets are also available with the 5028*i*. ▲

The ambient particulate is then drawn down a vertically mounted heated sample tube on each channel. The heat applied to the sampe is adjustable to either a fixed temperature or a RH-threshold at the filter spot by independent controlling for each channel. The purpose of heating the sample is to reduce particle bound water and to decrease the relative humidity (RH) of the sample stream. This is done to reduce positive artifact measurement that can potentially occur as a result of condensation on the filter tape or conditions of elevated humidity. The heaters are controlled by the CPU and the power applied is proportional to the conditions.

At the location where the sampling tube attaches to the Model 5028*i* instrument case, a radial insulated tube joins the sampling tube to the collection chamber on each channel. The particulate is drawn onto the glass fiber filter tape between the proportional detector and the C-14 beta source. Here, the beta beam passes upwards through the filter tape and accumulated particulate layer. The intensity of the beta beam is attenuated with the increasing mass load resulting in a reduced beta intensity measured by the proportional detector. From a continuously integrated count rate the mass on the filter tape is calculated. During sampling, the mass on the filter spot is always known and the rate of particulate accumulation is observed.

A continuous measurement of the flow rate determines the sample volume. Two proportional valves use to maintain the sample flow rate at its nominal value. From both integrated sample volume and mass detection, the particulate concentration is calculated for Channel A and Channel B. At any given time the output signal delivers the concentration of particulate in actual or standard conditions.

The Model 5028*i* outputs particulate matter concentrations to the front panel display as shown of PM and PMb, the analog outputs, and also makes the data available over the serial or Ethernet connection. A visible window of the Model 5028*i* can make an easy maintenance and service for engineers and users. Two bigger filter tapes with 42 meters can use for more spots.

Additionally, the Model 5028*i* proportional detector is sensitive to natural alpha activity of the aerosol passing through the sampling system. The additional alpha count rate is used to measure the presence of Radon gas and infer the daughter nuclides of Radon gas. These daughter nuclides create a small beta emission. This externally sampled beta emission is perceived by the detector to be a higher count rate and the higher the count rate, the less apparent mass detected. Therefore, by measuring the natural alpha activity due to Radon gas, the proportional beta interference from the daughter nuclide emissions are subtracted from the count rate to provide a refined mass measurement. This potential error from Radon gas interference may be (in lower strength radioactive devices; e.g.; <100 µCi) as high as actual particle concentrations, especially after filter change or when the natural activity concentration changes.

The Model 5028*i* has implemented this procedure to determine separately the natural activity in the aerosol and to eliminate this error for each measurement chamber. This procedure further allows the Model 5028*i* to provide a more stable reading at lower ambient particulate concentrations compared to similar methods. Furthermore, from this information the activity concentration of the natural noble gas Radon is derived.

The measurement chamber houses an RTD temperature sensor in each channel. The T-sensor directly measures the temperature of the incoming sample stream for a continuous air mass compensation, and the flow system. The flow and ambient sensor measurements are combined within a firmware algorithm to maintain an accurate measurement and control of volumetric flow at the inlet and through the differential orifice.

The Model 5028*i* also includes five pressure sensors to measure the differential pressure across a subsonic orifice, vacuum under the filter tape, and barometric pressure. The flow P-sensors are solely used for measurement at the orifice for flow rate control. The vacuum sensors use for air mass compensation, as an indicator for clogging of the system and are included in the volumetric flow control. The barometric P-sensor uses for air mass compensation and for volumetric flow rate regulation.

The volumetric flow system is built on a calibrated feedback signal from the CPU to the proportional valve signal. By using this flow control, flow stability is easily maintained.

Specifications

Table 1–1 lists the specifications for the Model 5028*i*.

Table 1–1. Model 5028*i* Specifications

Safety/Electrical Designations
Designed to meet:
CE: EN61326-1:2013, EN61326-2-2:2013, IEC/EN61010-1:2010; IEC/EN61010-2-081:2015
UL: 61010-1:2012, UL61010-2-081:2015
CSA: C22.2 No.61010-1:2012, CSA C22.2 No.61010-2-081, ICES-003 Issue 6 (2016)
FCC: CFR 47 Part 15:2015, ANSI C63.4:2014
Source and Detector
Two β Sources: Carbon-14, <3.7 MBq (<100 µCi) Sealed Source Device
Two Proportional Detectors
Standard System Configuration
Menu-driven software for user interaction via 320 x 420 pixels graphics display
Connecting and Interface Cables, and Vacuum Pump
Two 3-foot heated sample tubes
Ambient T/RH Assembly
Consumables for average first year’s operation (ambient)
*i*Port Software for Local or Remote Communication
Sample Heater
Two 3-foot insulated heater tube

Three Modes of Heater Control	OFF – Heater is turned off in non condensing environment TEMP – fixed sample temperature RH – Dynamic Heating of sample at set sample RH threshold (e.g., 50% RH)
Instrument Performance (16.67 l/min, 1s, stable conditions)	
Measurement Range:	0 to 0.1, 1.0, 2.0, 3.0, 5.0, 10.0 mg/m^3 0 to 100, 1,000, 2,000, 3,000, 5,000, 10,000 µg/m^3
Minimum Detection Limit:	<4 µg/m^3 (1 hour) @ 2 σ <1 µg/m^3 (24-hour) @ 2 σ
Resolution: 0.1 µg/m^3	
Precision: ±3.0 µg/m^3 <80 µg/m^3; 4-5 µg/m^3 >80 µg/m^3 (24-hour) RMS Precision: PM2.5 < 5%, PM10 < 5%(24-hour)	
Accuracy for Mass Measurement: ±5% using NIST-traceable mass foil set	
Data Averaging and Output	
Real-time Mass Conc Average: 20 minutes	
Long-Term Averaging: 60 to 3,600 sec and 24-hour	
Data Output Rate: every 1 second	
Operating Range	
The temperature of the sampled air may vary between -30 and 45 °C. The 5028*i* units must be weather protected within the range of 4 °C to 50 °C. An optional Complete Outdoor Enclosure provides complete weather protection.	
Non-condensing; <95% RH inside 5028*i*	
Sample Flow	
Volumetric flow control system uses a calibrated subsonic precision orifice and the measured ambient temperature and pressure to maintain constant volumetric flow rates. Nominal Flow Rate: 16.67 L/min Flow Precision ±2% of measured value Flow Accuracy <5% of measured value	
Data Storage	
Internal data logging of user-specified variables; capacity of 190,000 records.	
Filter Media	
Two Sample Filters: Glass fiber filter tape (width 40 mm; length: 42 m)	
Inlet Accessories	
TSP	
U.S. EPA PM10 Inlets	
U.S. EPA PM2.5 Inlet Configurations	
PM2.5 VSCC™	

PM1.0 SCC
Tripod
Data Output and Input
*i*Port software to view and change system operation from PC
Outputs: Selectable Voltage, RS232/RS485, TCP/IP, 10 Status Relays, and Power Fail Indication (standard). 0-20 or 4-20 mA Isolated Current Output (optional)
Inputs: 16 Digital Inputs (standard), Eight 0 to 10 VDC Analog Inputs (optional) 8 User-Defined Analog Outputs (0 -1 or 0 -5 VDC)
Protocols: C-Link, MODBUS, Geystitech (Bayern-Hessen), ESM Protocol, streaming data, and NTP (Network Time Protocol) protocols. Simultaneous connections from different locations over Ethernet.
2 User-Defined Contact Closure Alarm Circuits
4 Averaged Analog Inputs (0–5 VDC) with user-defined conversion to engineering units
Data Storage
Maximum of 190,000 Concentration records with date, time, and flags
Up to 32 types of logged data parameters, increased parameters reduces number of records
Power Requirements
Model 5028*i*: 100-120 VAC(5028i-A), 220-240 VAC(5028i-D), 50/60 Hz
Pump: 220 VAC 50/60 Hz, 2.0 A
Maximum Power: 700 Watts(110V); 700 Watts(220V)
Physical Dimensions
W: 18.96" (48.2 cm) x D: 22.23" (56.5 cm) x H: 23.43" (59.5 cm)
Weight: 110VAC: 77lbs. (35 kg), 220VAC: 66lbs.(30kg)

Chapter 2

Installation

The following installation procedures for the Model 5028*i* describes packaging, lifting the instrument, unpacking the instrument, setup and installation, including the sample tube and pump, and attaching the analog and/or digital outputs to a recording device. The installation should always be followed by instrument calibration as described in the "Calibration" chapter of this manual.

This chapter provides the following recommendations and procedures for installing the instrument:

Packaging and Transport

The Model 5028*i* instrument, power cord, and operator manual are shipped in an ISTA-3E-certified packaging and all other items/ accessories are shipped separately. The ISTA-3E-certified packaging is comprised of the instrument within an inner box which is secured within an outer box using foam and corner bracing. In this configuration, the packaging is ready for shipping by carrier domestically and internationally.

The inner box that the instrument resides in is an ISTA-3E-certified packaging and is appropriate for transporting the instrument on local paved roads to the monitoring site. Precautions should be taken to secure this package from shifting during local transport.

Using the ISTA-3E packaging is strongly recommended for transporting the instrument over poor roads or on highways.

Lifting

When lifting the instrument, use a procedure appropriate to lifting a heavy object, such as bending at the knees while keeping your back straight and upright. It is desirable to have two persons lifting, each grasp the instrument at the bottom and at the front handle of the unit.

Equipment Damage Do not attempt to lift the instrument by the cover or other external fittings. ▲

Unpacking and Inspection

If there is obvious damage to the shipping container when the instrument is received, notify the carrier immediately and hold for inspection. The carrier is responsible for any damage incurred during shipment.

Use the following procedure to unpack and inspect the instrument.

1. Remove the instrument from its shipping container(s) and set it on a table or bench that allows easy access to both the front and rear.
2. Check for possible damage during shipment.
3. Remove any protective plastic material from the case exterior.
4. Remove the external pump from its shipping container and place next to the instrument.

Acceptance Testing and Startup Procedures

The Model 5028*i* has been bench tested and calibrated at the factory prior to shipping. The mass sensors, RH sensor, internal sample temperature sensor, flowmeter temperature sensor, external ambient temperature sensor, barometric pressure, and volumetric flow rate have been calibrated to traceable standards. For a quick start, proceed immediately to the "Startup" procedures and skip the "Bench Acceptance Test".

To assure the best quality data, it is recommended that you perform an acceptance test. Furthermore, as part of a quality assurance program acceptance testing will be conducted prior to field installation. This is an excellent opportunity to compare the monitor to the primary and transfer standards that are being used within the monitoring program. Furthermore, it is an opportunity to assure that the monitor is operating according to the manufacturer specifications.

After acceptance testing, a completed monitoring installation will require final volumetric flow rate verification.

Acceptance Test

Prior to installing the Model 5028*i*, you should perform the acceptance testing procedures. These tests are conducted to evaluate the out-of-box performance of the instrument, perform any necessary calibrations prior to final site installation, and familiarize the user with the menu structure.

Use the following procedure to perform the bench acceptance test.

Equipment Required:

Model 5028*i*

Power Cord

Ambient Temperature/RH Cable Assembly

Vacuum Pump Assembly

Flow Adapter Assembly

NIST-traceable Thermometer

NIST-traceable Hygrometer

NIST-traceable Barometer

NIST-traceable Manometer(s)

NIST-traceable Volumetric Flow Transfer Standard

(**Do not use the heated sample tube assembly at this point**.)

1. After unpacking the instrument place the Model 5028*i* and accessories onto a table or bench located within a stable indoor environment. Open the front door and inspect the filter tapes. Leave the front door unlocked until after acceptance testing has been completed.

Note Prior to continuing with acceptance testing, the instrumentation and accessories should have sufficient time to equilibrate to room temperature due to temperature variations during shipping and/or storage. ▲

2. Following a sufficient equilibration period, connect the power cord to the rear of the instrument and to a properly grounded power supply.

Note If the Model 5028*i* turns ON at this point, set the power switch to the OFF position and then proceed. ▲

3. Connect the green vacuum tube to the pump intake and to one end of the blue fitter. Connect a short green vacuum tube to the other end of blue fitter and to Tee-union. By using transparent tube, port

2 of CHA value and port 2 of CHB value connect to anther two ends of Tee-union, port 3 of CHA value connects to CHA Gas, port 3 of CHB value connects to CHB Gas.

4. Connect the vacuum pump power cord to the white circular grounded power supply, labeled PUMP, on the rear panel of the instrument. Clockwise rotate the connector of pump to make sure firmly.
5. 3-way values for two channels need to fix on the rear panel firmly. Connect cables of two 3-way values to sockets rear panel that marked as CHA and CHB.
6. Connect the 4-pin Temperature/RH cable to the 4-pin connector labeled RH/TEMP on the rear of the monitor.
7. Be sure that the pressure sensor calibration port toggle switches on the rear panel are pushed outward and away from the barbed +/- Delta P.
8. Set monitor power switch to the ON position.

During startup, the iSeries splash screen will be shown followed by a mechanical filter tape change and a cycling of the pump power.

To continue with the acceptance testing:

- From the Main Menu select Diagnostics > **RH/Temperatures**.

```
RH/TEMPERATURES:
 AMBIENT RH          40.0  %
 SAMPLE RH           36.4  %
 AMBIENT TEMP        22.9  °C
 FLOW TEMP           23.9  °C
 BOARD TEMP          24.9  °C↓

 RANGE   AVG   DIAGS  ALARM
```

The RH/Temperatures screen (read only) displays the current relative humidity in percent and the temperature readings in °C. The board temperature is the air temperature measured by a sensor located on the measurement interface board.

- Press ◼ to return to the Diagnostics menu, and choose **Pressure/ Vacuum**.

```
PRESSURE/VACUUM:
 BAROMETRIC       760.1  mmHg
 VACUUM            60.5  mmHg
 FLOW              21.5  mmHg



 RANGE   AVG   DIAGS  ALARM
```

The Pressure/Vacuum screen (read only) displays the barometric, vacuum, and flow pressure readings in mmHg. The pressure is measured by a pressure transducer. The vacuum is the amount of vacuum under the filter tape. The flow pressure is the pressure differential across the orifice.

Table 2–1. Pressure Units Conversion

Pressure Conversions
mmHg = atm x 0.75006
mmHg = inHg x 25.4
mmHg = hPa x 0.75006

Assuming adequate time has passed for thermal equilibration (approximately 1 hour), and the vacuum pump has been drawing room air into the instrument, compare the ambient temperature, sample temperature, and flow temperature to your NIST traceable thermometer placed at the inlet tube (see Figure 2–1).

Note Please be sure that the pump exhaust or any other heat source is not influencing the sensor reading of the temperature/RH cable assembly. ▲

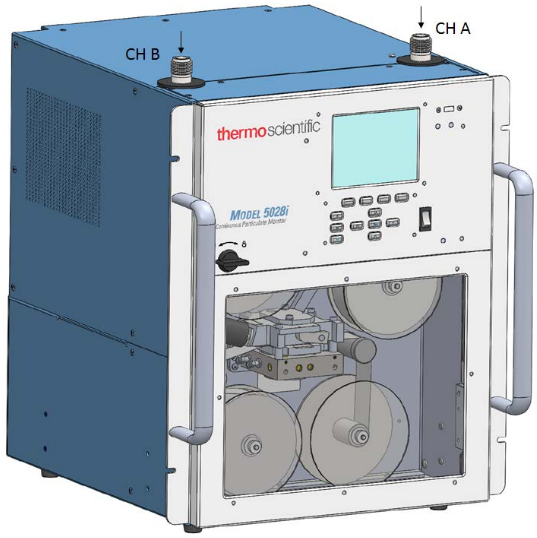


Figure 2–1. Model 5028*i* Sampling Room Air Under Stable Conditions

One-Point Temperature Verification

Record the temperature sensor readings from the Model 5028*i* and compare to your NIST-traceable thermometer. Each of these measurements should be within ±2 °C tolerance of your NIST-traceable thermometer. Within this tolerance, the temperature sensors have passed the acceptance test.

If the sensors are slightly out of tolerance (±3 °C), the acceptance test should be classified as marginal. If the sensor performance is outside this range, please perform a temperature sensor calibration.

For more information about the temperature sensor calibration, see the "Calibration" chapter.

One-Point RH Sensor Verification

Record the ambient RH sensor reading from the Model 5028*i* and compare to your NIST-traceable Hygrometer. The Model 5028*i* RH sensor should compare within ±2% RH tolerance of your NIST-traceable hygrometer. If the RH sensor performance is within this tolerance, the acceptance test has passed.

Note The ambient temperature verification should be completed prior to performing the RH-sensor verification due to a thermal compensation applied to the RH-sensor. Furthermore, try to avoid RH comparisons <30% RH and >80% RH. ▲

If the RH sensor is slightly out of tolerance, ±3% RH, the acceptance test should be classified as marginal. If the sensor performance is outside this range, please perform a RH-sensor calibration.

For more information about the RH sensor calibration, see the "Calibration" chapter.

It is recommended that the NIST-traceable hygrometer should also compare well with the RH-measurement used within a gravimetric laboratory that is part of a compliance program.

One-Point Barometric Pressure Verification

Record the Model 5028*i* barometric pressure sensor reading. This value is in units of mmHg. If necessary, using the pressure unit conversion (Table 2–1) to convert your NIST-traceable measurement to units of mmHg for an appropriate comparison. The Model 5028*i* barometric sensor should compare within ±10.0 mmHg tolerance of your NIST-traceable barometer. If the Model 5028*i* sensor performance is within this tolerance, the acceptance test has passed.

If the sensor is slightly out of tolerance, ±12 mmHg, the acceptance test should be classified as marginal. If the sensor performance is outside this range, please perform a sensor calibration.

For more information about the barometric pressure sensor calibration, see the "Calibration" chapter.

One-Point Volumetric Flow Rate Verification

The flow rate of the Model 5028*i* should be verified during this acceptance test. Prior to this test it is important for the previous temperature and pressure acceptance tests to be completed. Should the ambient temperature, flow temperature or barametric sensors require calibration, this should be done prior to the flow rate verification.

- Press [◼] to return to the Diagnostics menu, and choose Flows.

```
FLOW:              16.67 LPM



RANGE   AVG   DIAGS  ALARM
```

The Flow screen (read only) displays the volumetric flow rate in liters per minute. The flow is measured by the internal pressure board sensors.

Attach the small sample tube adapter to the Model 5028*i* inlet. Depending upon your NIST-traceable volumetric flow transfer standard (FTS), you may either attach your FTS now or add the flow audit adapter to accommodate any flexible tubing that your FTS may require. Allow 60 seconds to stabilize the flow after connecting.

Record the Model 5028*i* Volumetric Flow Rate as Qm and the FTS flow rate as Qi, assuring that both are being recorded in units of actual liters per minute. Take three readings each from Qm and Qi and average the respective values. Use the following equation to calculate the percent difference:

$$\%D = 100 \times \frac{Qm - Qi}{Qi}$$

If %D is within ±4%, then the Model 5028*i* volumetric flow rate acceptance test has passed. If the Model 5028*i* volumetric flow rate is slightly out of tolerance, ±5%, the acceptance test should be classified as marginal. If the volumetric flow rate performance is outside this range, please perform a volumetric flow calibration.

For more information about the volumetric flow rate calibration, see the "Calibration" chapter.

Setup

Setting up this monitor includes siting the monitor per local government agency requirements, creating a waterproof inlet system installation with vertical support, connecting the inlet system to the instrument through the dynamic heater system, connecting vacuum lines, establishing datalogging setting, and making the power connections.

Inlet System

When siting the inlet system, it is best to first establish the instrument location and height within the air monitoring station. From whatever chosen surface the instrument is to rest on (rack or table top), add approximately 17 inches to that height to allow for overall height of the 5028*i* monitor.

Next allow approximately 40 inches to attach the heated sample tube to the top of the 5028*i* via 5/8-inch OD tubing unions that use Teflon ferrules.

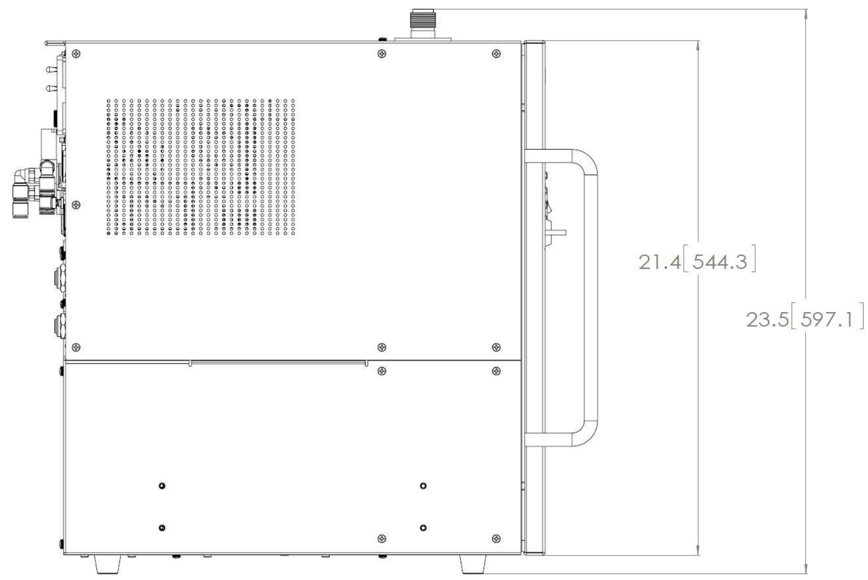


Figure 2–2. Model 5028*i* Side View—inches [millimeters]

It is also important to locate the roof flange installation in vertical alignment with the inlet of the instrument. By reviewing the top view drawing of the instrument (Figure 2–2), the roof flange must be centered in direct alignment with the 5/8-inch OD tube entering the 5028*i* instrument.

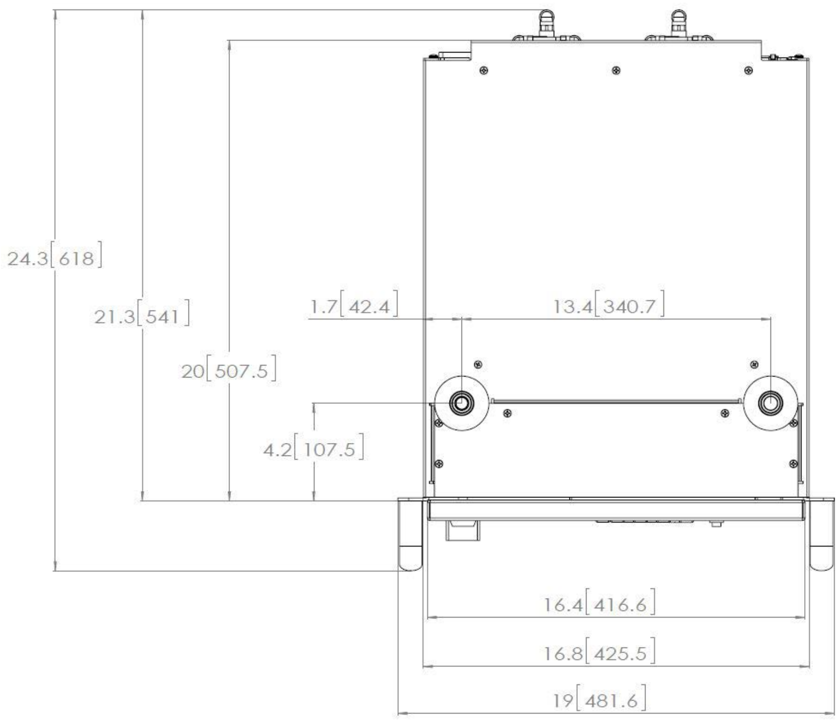


Figure 2–3. Model 5028*i* Top View—inches [millimeters]

Heater

Once the x-y coordinates of the instrument and roof flange system are established and a waterproof flange system has been installed, perform a dry run by attaching the heated sample tube on top of the 5028*i* base. If the heated tube protrudes through the roof flange, either the instrument should be lowered or an elongated PVC sleeve and cap system should cover the heater while maintaining a waterproof seal. However, for the remainder of this description, it is assumed the heater will fit within the ceiling height of the air monitoring station.

Based on the vertical height requirements, use additional 5/8-inch OD stainless tubing and connectors to make up the difference between the desired inlet height and the top of the heater.

Additional routing is necessary for the ambient T/RH sensor assembly.

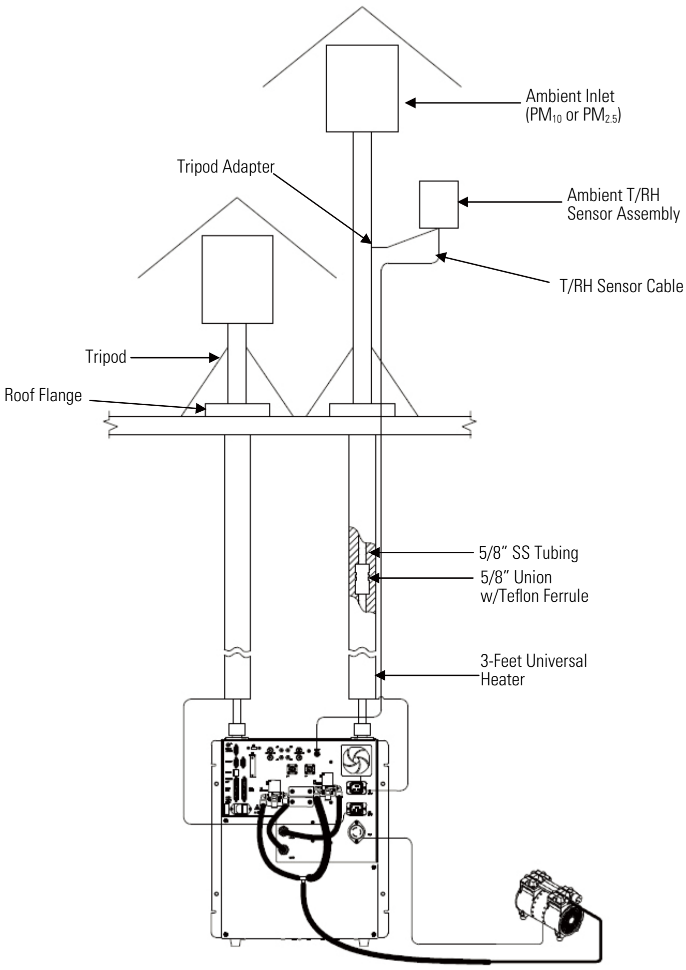


Figure 2–4. Model 5028*i* Vertical View

Sample Tube Extension Lengths

Sample tube extensions are used for added height. Two sample tube extensions for the Model 5028i separate vertically by minimum requirement of 18 Inches entrance-to-entrance. Usually 40 Inches from inlet top of one Channel to another inlet top is recommended.

Rack Mounting Option

One limiting factor when siting the Model 5028*i* is placement within a standard 19-inch rack mounting. Future planning should be made to reserve the topmost rack mounting position available due to the vertical positioning of the sample tube directly from the roof into the top of the Model 5028*i*. In addition, modification to the rack cabinet to accommodate the vertical tubing connection also needs to be considered prior to installation. For more information, see Chapter 9 "Optional Equipment".

Review the following installation steps prior to field installation.

Monitor Installation

Once all height requirements are established, the following steps are usually taken to complete the installation.

1. Open the front door of 5028*i* and inspect for proper filter tape installation.
2. Place 5028*i* unit in place of intended operation.
3. Attach the insulated heater tube assembly to the 5/8-inch OD tubes on top of the 5028*i* (Figure 2–5).

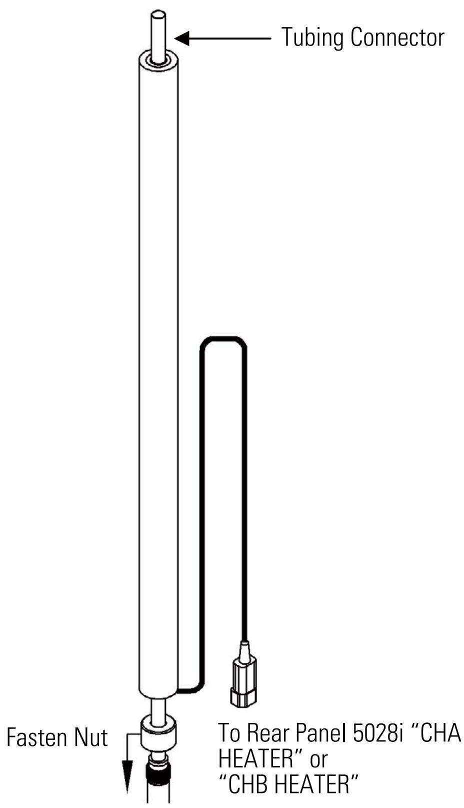


Figure 2–5. Heater Assembly

4. Attach a second tubing connector to the top of the heater tube.

5. Carefully push additional 5/8-inch OD stainless steel tubing through the roof flange and then drop into the tubing union on top of the heater.

6. Any exposed 5/8-inch OD stainless steel tubing should be insulated with additional pipe insulation inside the shelter.

7. Sleeve any additional water tight capping over the tubing that now extends above the roof line.

8. Sleeve the white Delrin plastic tripod adapter over the 5/8-inch OD tubing to an appropriate height to accommodate the tripod and ambient T/RH sensor assembly. Tighten this adapter against the stainless steel tubing using the two setscrews.

9. Sleeve the tripod over the tripod adapter to a proper height and tighten. Using the adjustable legs of the tripod, plumb the inlet tube assembly.

10. Attach the white ambient T/RH sensor radiation shield assembly onto a portion of the exposed tripod adapter.

11. Place the PM_{10} or $PM_{2.5}$ inlet into the 5/8-inch stainless steel tubing (all burrs should have been removed during installation).

12. Feed one end of the 25-foot T/RH cable trough the roof flange assembly and connect to the bottom of the ambient T/RH assembly.

13. Connect the other end of the T/RH cable to the back of the instrument (RH Temp).

14. Attach the heater power connectors to CHA HEATER/ CHB HEATER.

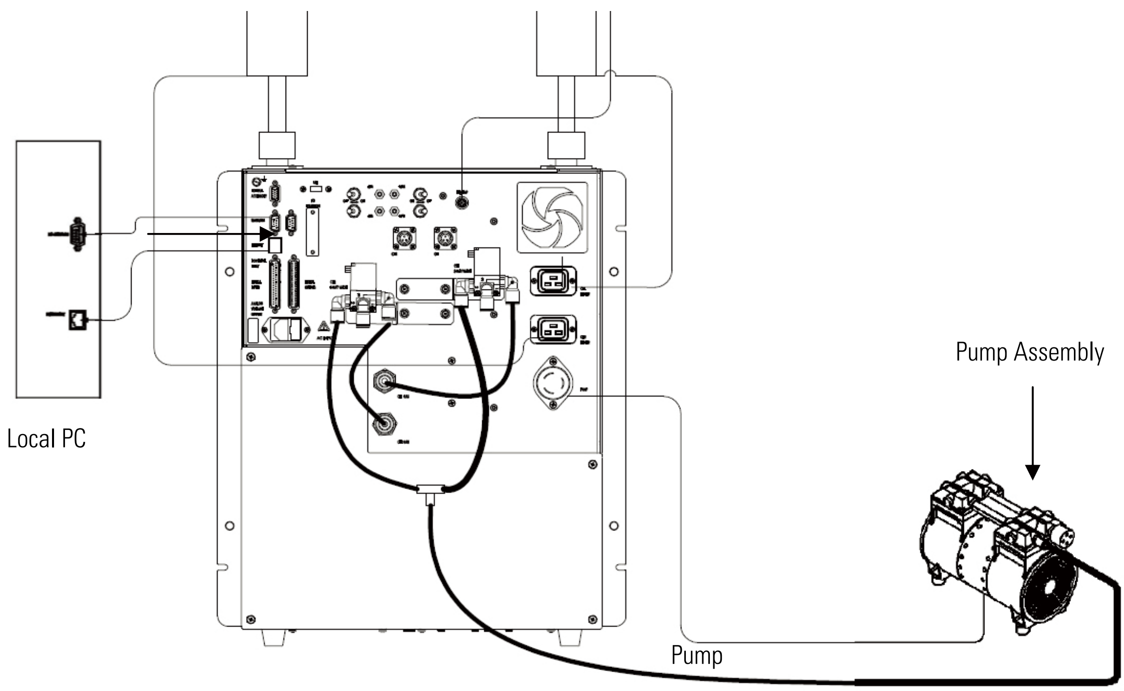


Figure 2–6. Rear Panel Plumbing Schematic

15. Using the available 3/8-inch green vacuum tubing, connect the intake of the pump to the tee-union fitting at the rear panel of the 5028*i*.

16. Plug the pump power into the PUMP receptacle at the rear of the 5028*i* base instrument. Need a rotation by hand to make the PUMP connector fixed on PUMP socket.

17. Connect the connector of 3-way valve of CHA and CHB to relative socket marked with CHA and CHB.

Connecting External Devices

Several components are available for connecting external devices to iSeries instruments.

These connection options include:

- Individual terminal board PCB assemblies (standard)
- Terminal block and cable kits (optional)
- Individual cables (optional)

For detailed information on the optional connection components, refer to the "Optional Equipment" chapter. For associated part numbers, refer to "External Device Connection Components" on page 7-7.

Terminal Board PCB Assemblies

The terminal board PCB assemblies are circuit boards with a D-Sub connector on one side and a series of screw terminals on the other side. These assemblies provide a convenient mechanism for connecting wires from a data system to the analyzer's I/O connectors.

The following terminal board PCB assemblies are available for iSeries instruments:

- I/O terminal board PCB assembly, 37 pin (standard)
- D/O terminal board PCB assembly, 37 pin (standard)
- 25-pin terminal board PCB assembly, (included with optional I/O expansion board)

I/O Terminal Board

Figure 2–7 shows the recommended method for attaching the cable (customer supplied) to the terminal board using the included tie-down and spacer. Table 2–2 identifies the connector pins and associated signals.

Note Not all of the I/O available in the instrument is brought out on the supplied terminal board. If more I/O is desired, an alternative means of connection is required. See optional "Terminal Block and Cable Kits". ▲

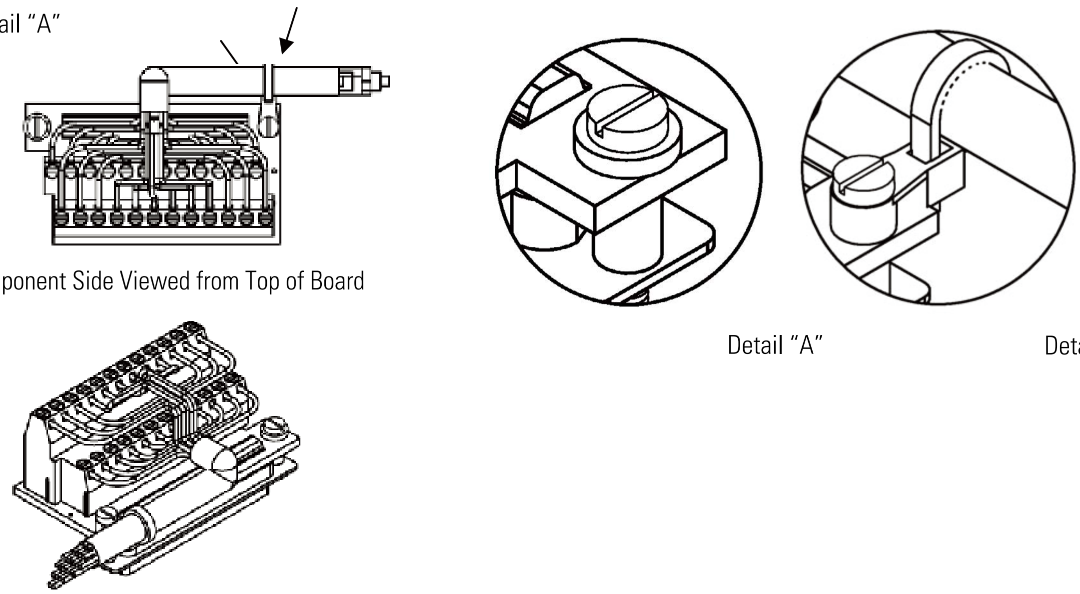


Figure 2–7. I/O Terminal Board Views

Table 2–2. I/O Terminal Board Pin Descriptions

Screw	Signal Description	Screw	Signal Description
1	Analog1	13	Power_Fail_NC
2	Analog ground	14	Power_Fail_COM
3	Analog2	15	Power_Fail_NO
4	Analog ground	16	TTL_Input1
5	Analog3	17	TTL_Input2
6	Analog ground	18	TTL_Input3
7	Analog4	19	TTL_Input4
8	Analog ground	20	Digital ground
9	Analog5	21	TTL_Input5
10	Analog ground	22	TTL_Input6
11	Analog6	23	TTL_Input7
12	Analog ground	24	Digital ground

The analog outputs are arranged on the rear panel connector as shown in Figure 2–8. See Table 2–3 for channels and pin connections.

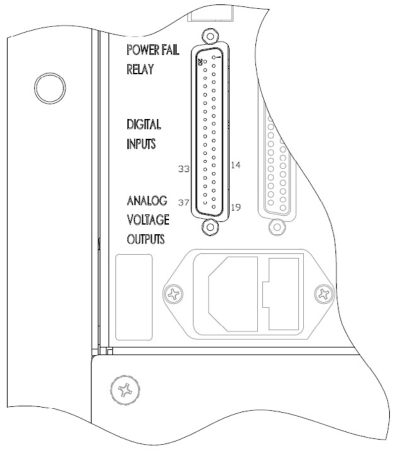


Figure 2–8. Pin-Out of Rear Panel Connector

Table 2–3. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	PM
2	33	3	AVG PM
3	15	5	Flow
4	34	7	Ambient Temperature
5	17	9	Flow Temperature
6	36	11	Ambient Relative Humidity
Ground	16, 18, 19, 35, 37	2, 4, 6, 8, 10, 12	Signal Ground

Note All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

D/O Terminal Board

Figure 2–9 shows the recommended method for attaching the cable (customer supplied) to the terminal board using the included tie-down and spacer. Table 2–4 identifies the connector pins and associated signals.

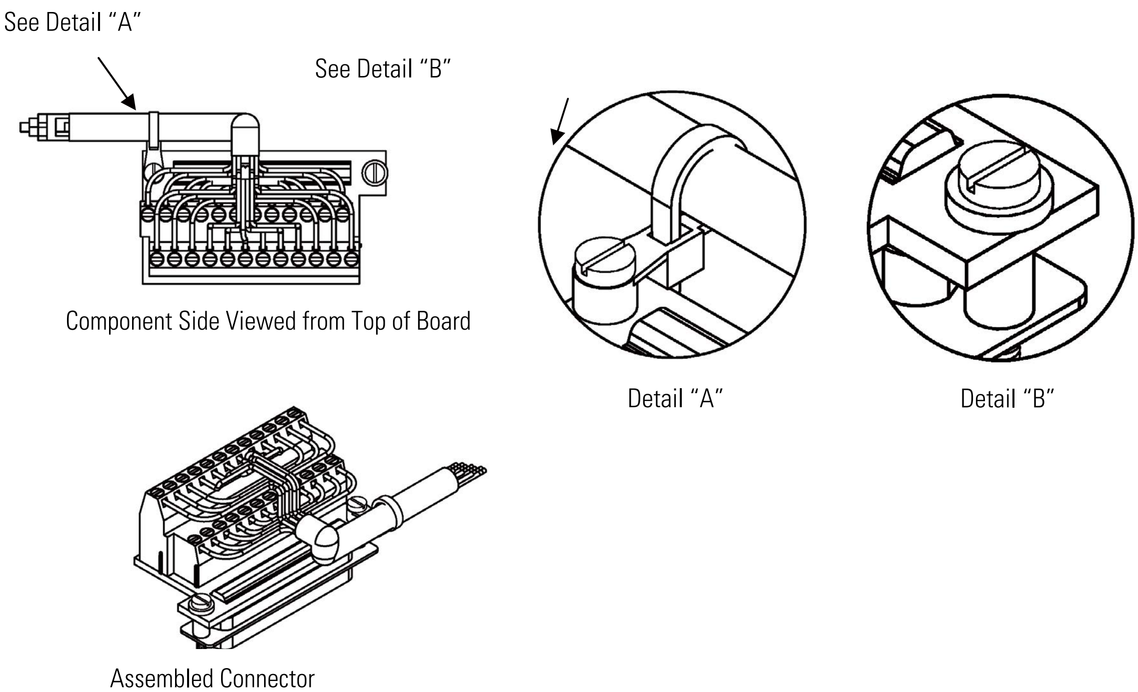


Figure 2–9. D/O Terminal Board Views

Table 2–4. D/O Terminal Board Pin Descriptions

Screw	Signal Description	Screw	Signal Description
1	Relay1_ContactA	13	Relay7_ContactA
2	Relay1_ContactB	14	Relay7_ContactB
3	Relay2_ContactA	15	Relay8_ContactA
4	Relay2_ContactB	16	Relay8_ContactB
5	Relay3_ContactA	17	Relay9_ContactA
6	Relay3_ContactB	18	Relay9_ContactB
7	Relay4_ContactA	19	Relay10_ContactA
8	Relay4_ContactB	20	Relay10_ContactB
9	Relay5_ContactA	21	(not used)
10	Relay5_ContactB	22	+24V
11	Relay6_ContactA	23	(not used)
12	Relay6_ContactB	24	+24V

25-Pin Terminal Board

The 25-pin terminal board is included with the optional I/O Expansion Board. Figure 2–10 shows the recommended method for attaching the cable (customer supplied) to the terminal board using the included tie-down and spacer. Table 2–5 identifies the connector pins and associated signals.

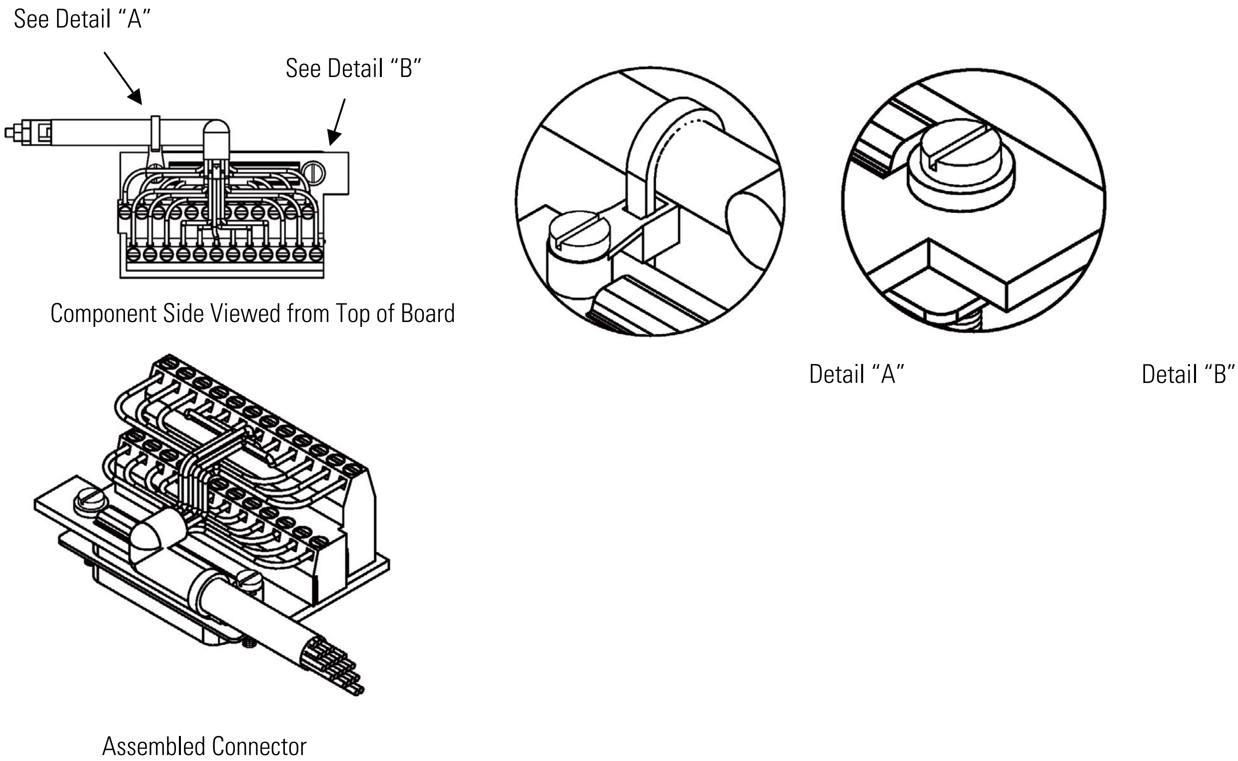


Figure 2–10. 25-Pin Terminal Board Views

Table 2–5. 25-Pin Terminal Board Pin Descriptions

Screw	Signal Description	Screw	Signal Description
1	IOut1	13	Analog_In1
2	Isolated ground	14	Analog_In2
3	IOut2	15	Analog_In3
4	Isolated ground	16	Ground
5	IOut3	17	Analog_In4
6	Isolated ground	18	Analog_In5
7	IOut4	19	Analog_In6
8	Isolated ground	20	Ground
9	IOut5	21	Analog_In7
10	Isolated ground	22	Analog_In8
11	IOut6	23	Ground
12	Isolated ground	24	Ground

Power Connections

Before the power is connected, be sure that the front door power switch is OFF and be sure to verify that the local power matches the label on the back of the monitor station.

WARNING The Model 5028*i* is supplied with a three-wire grounded power cord. Under no circumstances should this grounding system be defeated. ▲

Startup

Use the following procedure when starting the instrument.

1. Turn the power ON and allow 12 hours for the beta detector to stabilize.
2. Although the instrument has been calibrated at the factory, if the instrument has been equilibrated, temperature sensors may be checked. (Assure that the heater is off and that the instrument is sampling room air at a constant temperature for at least 1-2 hours with the cover removed.)
3. After a 12-hour stabilization, the following steps should be performed:
   a. From the Main Menu, choose **Instrument Controls**. Under Instrument Controls:
      i. Flow should be set to 16.67 LPM
      ii. Heater Control should be set to RH with a RH threshold of 50–58%. For lower RH threshold settings, please contact technical support.
      iii. Filter Tape mass limit should be set to 1,500 µg
      iv. Filter Tape–Next Time; this should have a start date
      v. Filter Tape Period should be set to 8 hours for $PM_{2.5}$ and PM_{10}. U.S. EPA applications may adjust this value as high as 24 hours for PM_{10} only. However, 8 hours is recommended for consistent performance.
      vi. Volumetric Conditions should be set to ACT for both Temp and Press
      vii. Lrecs and Srecs should be chosen for datalogging and all parameters should be selected in the order they appear from "Concentrations" to "Other Measurements". Default Lrecs are set to 60 minute logging with 30% memory and Srecs are 5-minute logging with 70% memory allocated. If there are any changes, be sure to Commit Content.

   b. From the Main Menu, choose Service. Under Service:

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

i. Check/Calibrate Ambient Temperature, Sample Temperature, and Flow Temperature

ii. Check/Calibrate Ambient RH

iii. Check Calibrate Barometric Pressure Span

iv. Check/Calibrate Flow Calibration

v. Perform a Auto Detector Calibration (30 minutes)

vi. Perform a Mass Foil Calibration (factory calibrated)

vii. Mass Coefficients are set at the factory.

Data Content

Please use iPort to access data download from the instrument.

Shutdown

Use the following procedure when shutting down the instrument.

1. Turn the power OFF.
2. Cover instrument ports when not in use.

Important Tips

DO NOT

- Do not pressurize the monitor.
- Do not allow liquids to enter the sample port.
- Do not expose the instrument to excessive vibration or magnetic interference.
- Do not remove/adjust the beta attenuation bench of the 5028*i*.
- Do not remove the C-14 radioactive source at any time.

DO

- Operate the instrument in a climate-controlled environment (4–50 °C).
- Set DHCP to ON when changing the IP address.

Chapter 3
Operation

This chapter describes the front panel display screens, front panel pushbuttons, and menu-driven firmware. For details, see the following topics:

Display

The 320 x 240 pixels graphics liquid-crystal display (LCD) shows the sample concentrations, instrument parameters, instrument controls, help, and error messages. Some menus contain more items than can be displayed at one time. For these menus, use ↑ and ↓ to move the cursor up and down to each item.

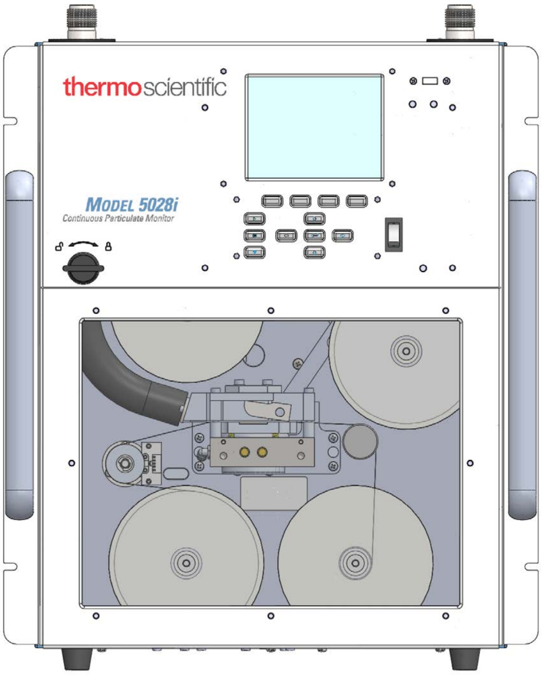


Figure 3–1. Front Panel Display

CAUTION If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲

Pushbuttons

The Pushbuttons allow the user to traverse the various screens/menus.

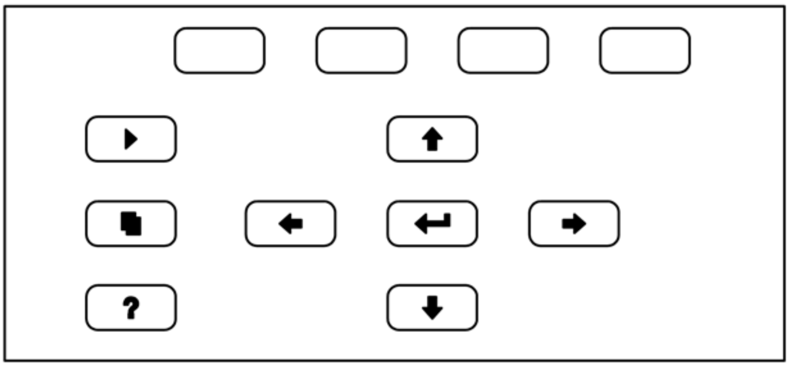


Figure 3–2. Front Panel Pushbuttons

Table 3–1 lists the front panel pushbuttons and their functions.

Table 3–1. Front Panel Pushbuttons

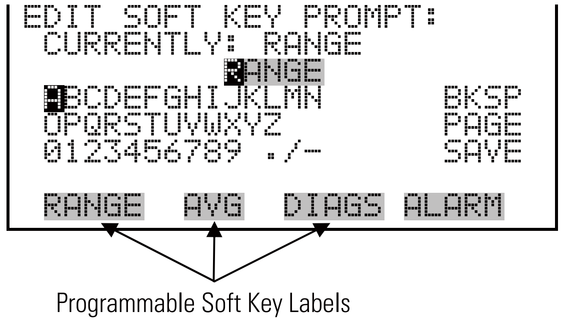
Key Name	Function
[ ] = Soft Keys	The [ ] (soft keys) are used to provide shortcuts that allow the user to jump to user-selectable menu screens. For more information on processing soft keys, see "Soft Keys" below.
[▶] = Run	The [▶] is used to display the Run screen. The Run screen normally displays the current PM concentrations, but also has additional Run screens for ambient conditions, sample conditions, and mass sensor data. Press [↑] and [↓] to scroll through the different Run screens.
[■] = Menu	The [■] is used to display the Main Menu when in the Run screen, or back up one level in the menu system. For more information about the Main Menu, see "Main Menu" later in this chapter.
[?] = Help	The [?] is context-sensitive, that is, it provides additional information about the screen that is being displayed. Press [?] for a brief explanation about the current screen or menu. Help messages are displayed using lower case letters to easily distinguish them from the operating screens. Press [▶] to return to the Run screen, or any other key to exit a help screen.
[↑] [↓] = Up, Down [←] [→] = Left, Right	The four arrow pushbuttons ([↑], [↓], [←], and [→]) move the cursor up, down, left, and right or change values and states in specific screens.
[↵] = Enter	The [↵] is used to select a menu item, accept/set/save a change, and/or toggle on/off functions.

Soft Keys

The soft keys are multi-functional keys that use part of the display to identify their function. The function of the soft keys is to provide a shortcut to the most often used menus and screens. They are located directly underneath the display, and user-defined labels in the lower part of the display indicate the function of each key at that time.

To change a soft key, place the menu cursor ">" on the item of the selected menu or screen you wish to set. Press [→] followed by the selected soft key within 1 second of pressing the right-arrow key. The "edit soft key prompt" will be displayed for configuration of the new label.

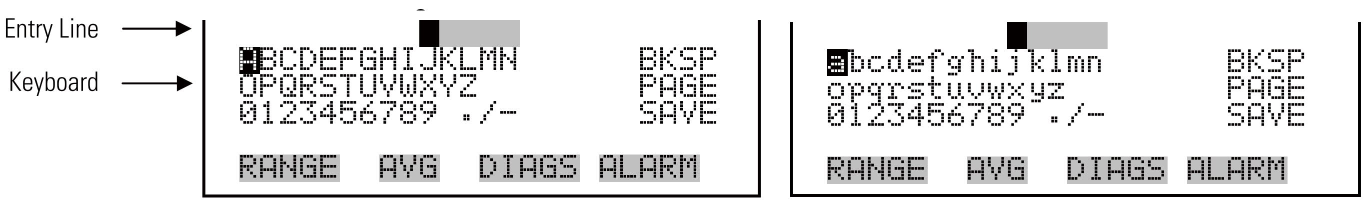
Note Not all menu items may be assigned to soft keys. If a particular menu or screen item cannot be assigned, the key assignment screen will not come up upon entering right-arrow-soft key combinations. All items under the Service menu (including the menu itself) cannot be assigned soft keys. ▲



Alphanumeric Entry Screen

The alphanumeric entry screen is used to enter strings consisting of letters, numbers, and other characters. The cursor may be positioned within the entry line using the ← and → keys. If a character is entered over an existing character, that character will be overwritten. Use the ↑ and ↓ keys to switch between the entry line and the keyboard as well as to move within the keyboard. To select a character to add to the string, use the cursor keys to position the cursor over the desired character, and then press the ↵ key to add that character to the entry line.

On the right side of the keyboard are special functions. BKSP is used to move the cursor in the entry line one place to the left, deleting the character that was to the left of the cursor and moving any character at or to the right of the cursor one place to the left. PAGE is used to change the keyboard character page. For the English language, this switches between upper and lower-case alphabetic characters. SAVE stores the string from the entry line into the parameter. Alternately, if the active cursor is moved to the entry line, ↵ may be pressed to store the string from the entry line into the parameter.



Firmware Overview

The Model 5028*i* utilizes the menu-driven firmware as illustrated by the flowchart in Figure 3–3. The Power-Up screen, shown at the top of the flowchart, is displayed each time the instrument is turned on. This screen is displayed while the instrument is warming up and performing self-checks. After the warm-up period, the Run screen is automatically displayed. The Run screen normally displays the current PM concentrations, but also has additional Run screens for ambient conditions, sample conditions, and mass sensor data. From the Run screen, the Main Menu can be displayed by pressing (■). The Main Menu contains a list of submenus. Each submenu contains related instrument settings. This chapter describes each submenu and screen in detail. Refer to the appropriate sections for more information.

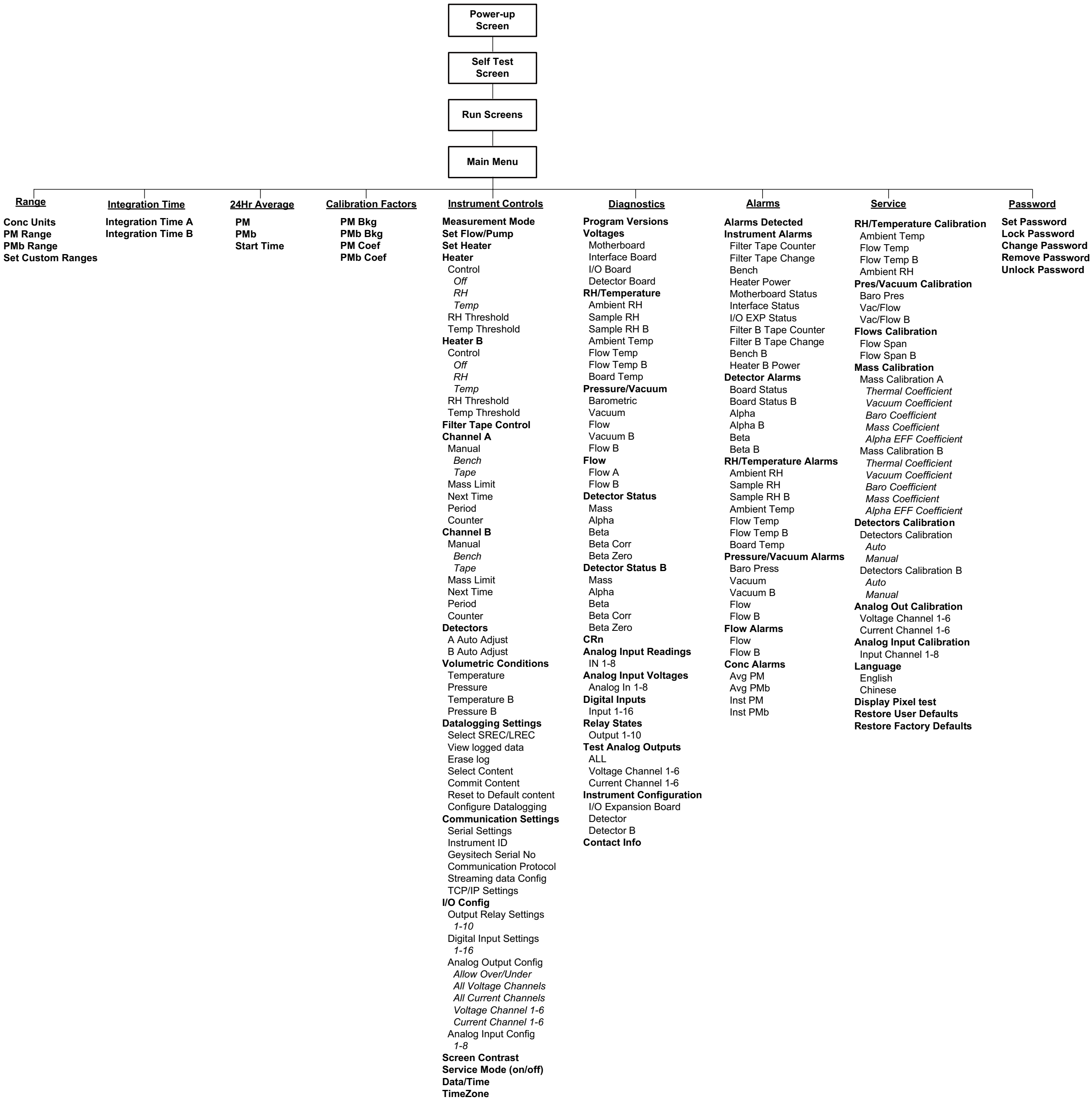


Figure 3–3. Flowchart of Menu-Driven Firmware

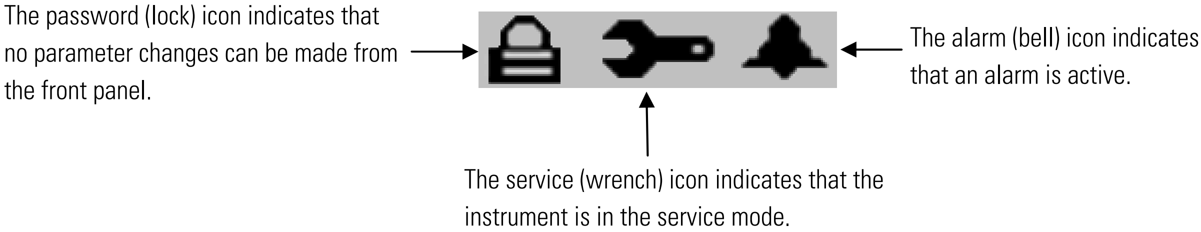
Power-Up Screen

The Power-Up screen is displayed when power is applied to the Model 5028*i*. This screen is displayed while the internal components are warming up and diagnostic checks are being performed.

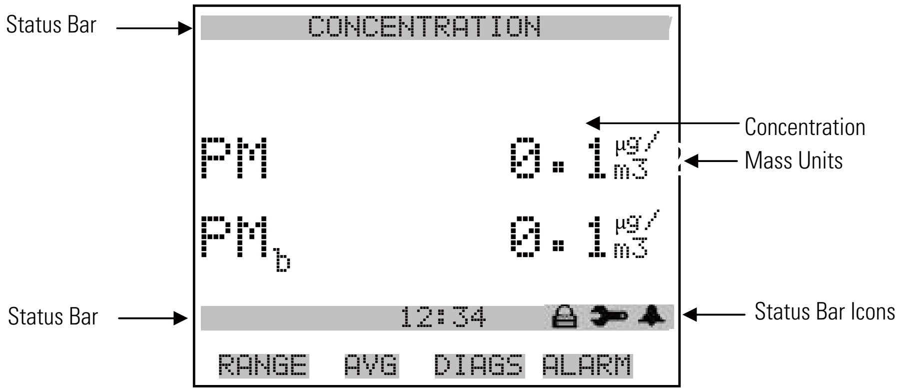
Run Screens

The Run screens display the PM concentration, ambient conditions, sample conditions, and mass sensor data. The status bar displays the time (24-hour format), the password (lock) icon, service (wrench) icon, alarm (bell) icon, and optional zero/span sample solenoid valve status, if installed.

Status Bar Icons

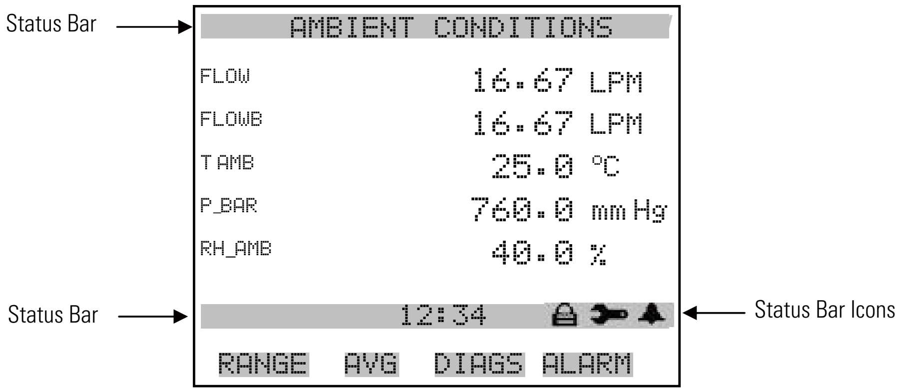


The Run screen normally displays the current particulate matter (PM) concentrations, but also has additional Run screens for ambient conditions, sample conditions, and mass sensor data. Pressing ⬆ and ⬇ will scroll through the different Run screens.



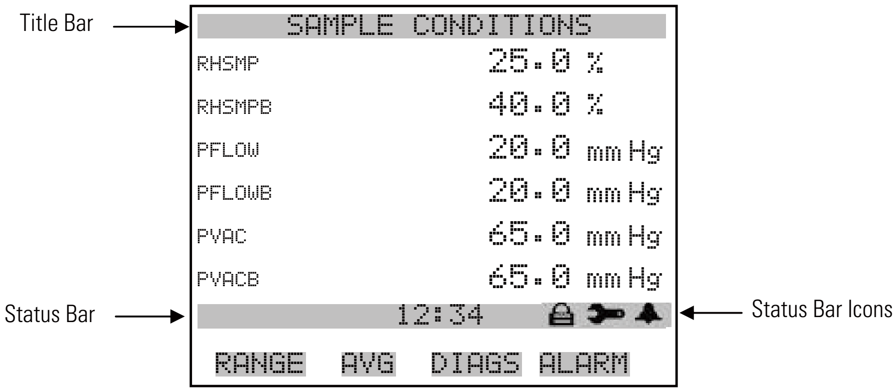
Ambient Conditions Run Screen

The Ambient Conditions Run screen displays the real-time volumetric flow rate at the inlet, the ambient temperature, the barometric pressure, and the ambient relative humidity.



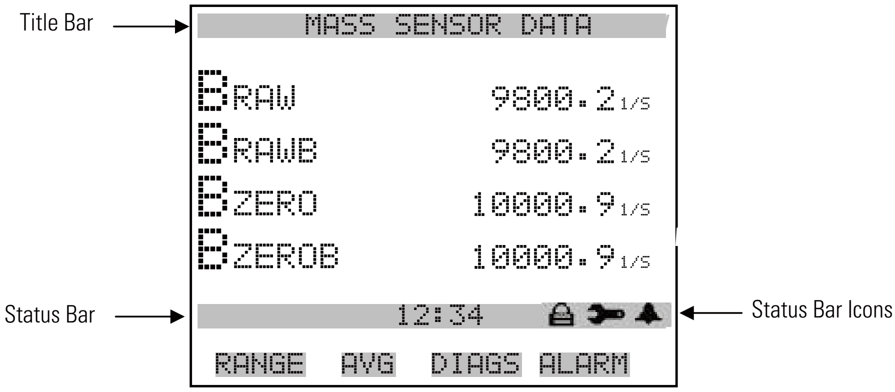
Sample Conditions Run Screen

The Ambient Conditions Run screen displays the sample filter temperature, the sample filter relative humidity, the differential pressure across the orifice, and the vacuum under the filter tape.



Mass Sensor Data Run Screen

The Mass Sensor Data Run screen displays the real-time beta counts during attenuation and the initial beta counts from a fresh filter spot.



Main Menu

The Main Menu contains a number of submenus. Instrument parameters and settings can be read and modified within the submenus according to their function. The concentration appears above the Main Menu and submenus in every screen. The Service menu is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" later in this chapter.

- Use ↑ and ↓ to move the cursor up and down.
- Press ↵ to make a selection.
- Press ■ to return to the Main Menu or ▶ to return to the Run screen.

```
      CONCENTRATION
 PM              15.0  µg/m3
 PMb             15.0  µg/m3
            12:34
MAIN MENU:
>RANGE
 INTEGRATION   TIME
 24HR AVERAGE
 CALIBRATION FACTORS
 INSTRUMENT CONTROLS
 DIAGNOSTICS
 ALARMS
 RANGE  AVG  DIAGS ALARM

 SERVICE
 PASSWOR
```

Range Menu

The Range menu allows the operator to select the concentration units, PM/PM_b standard ranges, and to set the custom ranges.

Note PM_b Range settings please refer to PM Range as following description. ▲

- In the Main Menu, choose **Range**

```
RANGE:
>CONC UNITS          µg/m3
 PM RANGE            10000
 PMb RANGE           10000
 SET CUSTOM   RANGES

 RANGE  AVG  DIAGS ALARM
```

Concentration Units

The Concentration Units screen defines how the particles concentration readings are expressed. Concentration units of micrograms per cubic meter (µg/m^3) and milligrams per cubic meter (mg/m^3) are available.

When switching the selected units, the instrument's analog ranges all default to the highest range. For example, when switching from mg/m^3 to µg/m^3, the ranges default to 10000 µg/m^3. Therefore, whenever you change units, you should also check the range settings.

Note If the units change, the instrument should be re-calibrated. A display warning will appear. ▲

- In the Main Menu, choose Range > **Conc Units**.

```
CONC UNITS:
  CURRENTLY:          mg/m3
     SET TO:          µg/m3 ?

 ↑↓ CHANGE VALUE     ← SAVE
 RANGE   AVG   DIAGS ALARM
```

Range

The Range screen defines the concentration range of the analog outputs. For example, PM/PM_b range of 0–100 µg/m^3 sets the analog output to concentrations between 0 and 100 µg/m^3 by default.

Note PM_b Range settings please refer to PM Range as following description. ▲

The display shows the current PM/PM_b range. The next line of the display is used to change the range.

Table 3–2 lists the standard ranges.

- In the Main Menu, choose Range > **PM Range or PM_b Range**.

```
PM RANGE:
 CURRENTLY:           100.0
    SET TO:            1000 ?

             ↑↓ CHANGE VALUE
              ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Table 3–2. Standard Ranges

mg/m^3	µg/m^3
0.1	100
1.0	1000
2.0	2000
3.0	3000
5.0	5000
10.00	10000
C1	C1
C2	C2
C3	C3

C1, C2, and C3 are custom ranges. For more information about custom ranges, see “Set Custom Ranges” below.

The analog outputs are arranged on the rear panel connector as shown in Figure 3–4. See Table 3–3 for channels and pin connections.

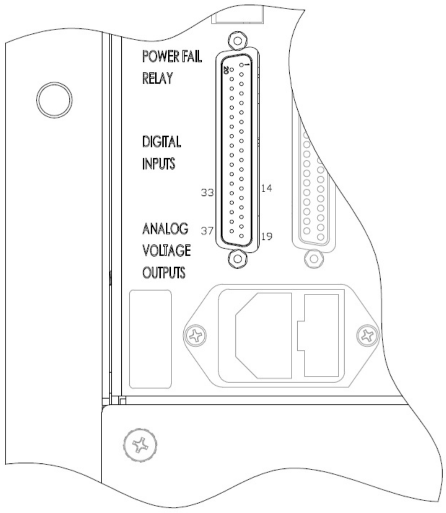


Figure 3–4. Pin-Out of Rear Panel Connector

Table 3–3. Default Analog Outputs

Channel	Connector Pin	I/O Terminal Pin	Description
1	14	1	PM
2	33	3	AVG PM
3	15	5	Flow
4	34	7	Ambient Temperature
5	17	9	Flow Temperature
6	36	11	Ambient Relative Humidity
Ground	16, 18, 19, 35, 37	2, 4, 6, 8, 10, 12	Signal Ground

Note All channels are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

Set Custom Ranges

The Set Custom Ranges menu lists three custom ranges, which are user-defined. In the mg/m^3 mode, any value between 0.1 mg/m^3 and 10.00 mg/m^3 can be specified as a range. In the µg/m^3 mode, any value between 100 µg/m^3 and 10000 µg/m^3 can be specified as a range.

- In the Main Menu, choose Range > **Set Custom Ranges**.

```
CUSTOM RANGES:
>CUSTOM RANGE 1      555.6
 CUSTOM RANGE 2     1875.0
 CUSTOM RANGE 3     8125.0



 RANGE  AVG  DIAGS ALARM
```

Custom Ranges

The Custom Ranges screen is used to define the custom ranges.

The display shows the current custom range. The next line of the display is used to set the range. For more information about selecting ranges, see "Range" above.

- In the Main Menu, choose Range > Set Custom Ranges > **Custom Range 1, 2,** or **3**.

```
CUSTOM RANGE 1:
 CURRENTLY:          555.6
    SET TO:       000555.7 ?

             ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ← SAVE

 RANGE   AVG   DIAGS ALARM
```

Integration Time

Integration time menu allows the operator to select the measurement of time interval for the channel A or channel B. To adjust the integration time interval, Integration Time ensure the measured values are calculated by the average value, and the average value is measured as the output of the measured value.Integration time interval can be selected from the 6 values that are preset (15, 20, 30, 40, 45 and 60 minutes).

Note Integration Time B settings please refer to Integration Time A as following description. ▲

- In the Main Menu, choose Integration Time>**Integration Time A or Integration Time B**.

```
INTEGRATION TIME:
>INTEGRATION TIME A
 INTEGRATION TIME B




 RANGE   AVG   DIAGS ALARM
```

```
INTEGRATION TIME A:
CURRENTLY:        20 MIN
   SET TO:        15 MIN ?

             ↑↓ CHANGE VALUE
              ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

24-Hour Average

The 24-Hour Average screen defines a start time during which concentration measurement is averaged over a daily 24-hours period. The average concentration of the primary readings are calculated for that time period and averaged out. A new 24-hour average concentration is displayed once per day. The display shows the current 24-hour average PM/PM_b concentration. The next line of the display is used to change the 24-hour averaging time.

- In the Main Menu, choose **24HR Averages**.

```
24HR AVERAGE:
 PM
 PMb
>START TIME         00:00


 RANGE  AVG  DIAGS ALARM
```

24-Hour Average Start Time

The 24-Hour Average Start Time screen allows the user to adjust the 24-hour averaging start time.

- In the Main Menu, choose 24HR Averages > **Start Time**.

```
24HR AVERAGE START TIME:
 CURRENTLY:        00:00
    SET TO:        01:00 ?

        ➡ SET HOURS
 ⬆⬇ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Calibration Factors Menu

Calibration factors are determined during automatic and manual calibration and are used to correct the concentration readings. The Calibration Factors menu displays the calibration factors as shown below. The instrument can also be calibrated manually using this menu. For more information about calibration, see Chapter 4, "Calibration".

The calibration factors for the PM/PM$_b$ BKG (offset) and PM/PM$_b$ COEF (slope) are set to 0.0 and 1.0 by default. Should regional settings require an adjustment to these values that DO NOT compromise regulatory approvals for this instrument, those values can be adjusted at this point.

- In the Main Menu, choose **Calibration Factors**.

```
CALIBRATION FACTORS:
>PM BKG                0.0
 PMb BKG               0.0
 PM COEF             1.000
 PMb COEF            1.000

 RANGE  AVG  DIAGS ALARM
```

PM/PM$_b$ Background

The PM/PM$_b$ Background screen allows the user to manually adjust the PM/PM$_b$ Intercept. The PM/PM$_b$ concentration based on the SET BKG TO is displayed to facilitate the setting. The PM/PM$_b$ concentration displayed in the Run portion of the screen is NOT affected by the SET BKG until the value is saved.

Note PM_b Background settings please refer to PM Background as following description. ▲

- In the Main Menu, choose Calibration Factors > PM Bkg or PM_b Bkg.

```
PM BACKGROUND:
 CURRENTLY:           0.0
    SET TO:           0.0 ?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

PM/PM_b Coefficient

The PM/PM_b Coefficient screen allows the user to manually adjust the PM/PM_b coefficient. The PM/PM_b concentration based on the SET COEF TO is displayed to facilitate setting. The PM/PM_b concentration displayed in the Run portion of the screen is NOT affected by the SET COEF until the value is saved.

- In the Main Menu, choose Calibration Factors > **PM Coef or PM_b Coef**.

Note PM_b Coefficient settings please refer to PM Coefficient as following description. ▲

```
PM COEFFICIENT:
 CURRENTLY:         1.000
    SET TO:         1.000 ?

           ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Instrument Controls Menu

The Instrument Controls menu contains a number of items that may be selected to control various instrument operational parameters. The firmware controls listed in this menu enable control of the listed instrument functions.

- In the Main Menu, choose **Instrument Controls**.

```
INSTRUMENT CONTROLS:
>MEASUREMENT MODE
 SET FLOW/PUMP
 SET HEATER
 FILTER TAPE CONTROL
 DETECTORS
 VOLUMETRIC CONDITIONS
 DATALOGGING SETTINGS     ↓

 RANGE  AVG  DIAGS ALARM

 COMMUNICATION SETTINGS
 I/O CONFIGURATION
 SCREEN CONTRAST
 SERVICE MODE
 DATE/TIME
 TIMEZONE
```

Measurement Mode

The Measurement Mode menu allows the operator to select the measurement channel for A, B or AB.

- In the Main Menu, choose **Instrument Controls>Measurement Mode**.

```
MODE:
 CURRENTLY:        MODE AB
    SET TO:        MODE A ?

             ↑↓ CHANGE VALUE
              ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Set Flow/Pump

The Set Flow/Pump menu allows the user to manually adjust the flow values, and to change the operating state of the pump to ON or OFF.

- In the Main Menu, choose Instrument Controls > **Set Flow/Pump**.

```
FLOW/PUMP:
>FLOW                16.67
 FLOW B              16.67
 PUMP VALUE             ON
 PUMP VALUE B           ON

 RANGE  AVG  DIAGS ALARM
```

Flow

The Flow screen is used to view and adjust the flow.

Note Flow B settings please refer to Flow as following description. ▲

- In the Main Menu, choose Instrument Controls > Set Flow/Pump > **Flow or Flow B**.

```
FLOW:
 CURRENTLY:     16.67 LPM
    SET TO:     16.67 LPM

             ↑↓ INC/DEC
              ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Pump Value

The PumpValue screen allows the user to toggle the pump to either ON or OFF.

Note Pump Value B settings please refer to Pump Value as following description. ▲

- In the Main Menu, choose Instrument Controls > Set Flow/Pump > **Pump Value or Pump Value B**

```
PUMP VALUE:
 CURRENTLY:            ON
    SET TO:           OFF ?

            ← TOGGLE VALUE

 RANGE  AVG  DIAGS ALARM
```

Set Heater

The Set Heater menu allows the user to set the status of the heater, RH threshold, and temperature threshold in various modes.

- In the Main Menu, choose Instrument Controls > **Set Heaters**.

```
HEATER:
>HEATER               TEMP
 HEATER   B           TEMP



 RANGE  AVG  DIAGS ALARM
```

HEATERS

The Heater screen is used to set the status of the heater to either ON/OFF, RH threshold, or TEMP threshold.

Note Heater B settings please refer to Heater as following description. ▲

- In the Main Menu, choose Instrument Controls > Set Heaters > **Heater or Heater B**

```
HEATER CONTROL:
 CURRENTLY:          OFF
    SET TO:           RH

 ↑↓ CHANGE VALUE    ↵ SAVE
 RANGE  AVG  DIAGS ALARM
```

RH Threshold

The RH Threshold screen is used to change the RH threshold value in percent. The RH threshold is typically compatible with the gravimetric method being used for comparison.

Note Heater B settings please refer to Heater as following description. ▲

- In the Main Menu, choose Instrument Controls >Set Heaters Heater or Heater B > **RH Threshold**.

```
RH THRESHOLD:
 CURRENTLY:          65 %
    SET TO:          35 %?

          ↑↓ INC/DEC
           ↵ SAVE VALUE
 RANGE  AVG  DIAGS ALARM
```

Temperature Threshold

The Temperature Threshold screen is used to change the temperature threshold value.

Note Heater B settings please refer to Heater as following description. ▲

- In the Main Menu, choose Instrument Controls > Set Heaters> Heater or Heater B > **Temp Threshold**.

```
TEMP THRESHOLD:
 CURRENTLY:         25 °C
    SET TO:         30 °C?

          ↑↓ INC/DEC
           ↵ SAVE VALUE
 RANGE  AVG  DIAGS ALARM
```

Filter Tape Control

The Filter Tape Control menu allows the user to manually move or set the next time period for tape control.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > **Filter Tape Control**.

```
FILTER TAPE CONTROL:
>CHANNEL  A
 CHANNEL  B



 RANGE   AVG   DIAGS ALARM
```

```
CHANNEL:
>MANUAL
 MASS LIMIT        1,500 µg
 NEXT TIME  05MAY08 00:00
 PERIOD             8 HRS
 COUNTER                0

 RANGE   AVG   DIAGS ALARM
```

Manual The Manual screen allows the user to move or stop the filter tape and open or close the measurement bench.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > Filter Tape Control > Channel A or Channel B>**Manual**.

```
MANUAL:
>BENCH(S)         CLOSED
 TAPE               STOP

           ↵ TOGGLE VALUE


 RANGE   AVG   DIAGS ALARM
```

Mass Limit The Mass Limit screen allows the user to set the mass limit. The default is 1,500 µg (or 1.5 mg) and is specified as part of any U.S. EPA and TUV approvals. However, the limit can be increased as much as 5,000 µg for non-regulatory monitoring.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > Filter Tape Control > Channel A orChannel B> **Mass Limit**.

```
MASS LIMIT:
 CURRENTLY:          1500
    SET TO:          1501 ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Next Time The Next Time screen is used to view and set the initial date and time (24-hour format) for the next filter tape change.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > Filter Tape Control > Channel A or Channel B>**Next Time**.

```
START DATE AND TIME:
 16 AUG 2016  00:00
 PRESS ↵ TO EDIT




 RANGE  AVG  DIAGS ALARM
```

```
START DATE AND TIME:
 16 AUG 2016  00:00 ?
 SETTING:  DAYS
              → SET MONTHS
             ↑↓ CHANGE VALUE
              ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Period The Period screen allows the user to set the period. The next filter tape change would be scheduled after the number of hours the period is set for. The official tape change for TUV and U.S. EPA for PM2.5 and PM10 is set for 8 hours.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > Filter Tape Control > Channel A orChannel B> **Period**.

```
PERIOD:
 CURRENTLY:        24 HRS
    SET TO:    000008 HRS?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Counter

The Counter screen allows the user to record the current filter tape count and reset the tape count to zero.

Note Channel B settings please refer to Channel A as following description. ▲

- In the Main Menu, choose Instrument Controls > Filter Tape Control > Channel A orChannel B>**Counter**.

```
FILTER TAPE COUNTER:     0
          ↵ RESET TO ZERO

 RANGE  AVG  DIAGS ALARM
```

Detectors

The Detectors menu allows the operator to select the instrument detects channel A or channel B automatically. And it's used to set the AUTO ADJUST A or AUTO ADJUST B status to either ON or OFF for the selected record type.

- In the Main Menu, choose **Instrument Controls>Detectors**.

```
DETECTORS:
>A AUTO ADJUST       OFF
 B AUTO ADJUST       OFF

 RANGE  AVG  DIAGS ALARM
```

Volumetric Conditions

The Volumetric Conditions menu allows the user to turn temperature/ pressure compensation on and off and to set the standard pressure and temperature values in various modes.

- In the Main Menu, choose Instrument Controls > **Volumetric Conditions**.

```
VOLUMETRIC CONDITIONS:
>TEMPERATURE         ACT
 PRESSURE            STD
 TEMPERATURE   B     ACT
 PRESSURE   B        STD

 RANGE  AVG  DIAGS ALARM
```

Temperature Compensation

The Temperature screen is used to turn the temperature correction to actual or standard.

Note Temperture B settings please refer to Tempertrue as following description. ▲

- Press ↵ to toggle and set the temperature compensation to actual or standard.

```
TEMPERATURE:
>COMPENSATION         ACT
 STANDARD           25 °C



 RANGE  AVG  DIAGS ALARM
```

Standard

The Standard Temperature screen is used to set the standard temperature.

Note Temperture B settings please refer to Tempertrue as following description. ▲

- In the Main Menu, choose Instrument Controls > Volumetric Conditions > Temperature or Temperture B > **Standard**.

```
STANDARD TEMPERATURE:
 CURRENTLY:         25 °C
    SET TO:        0.0 °C ?

           ↑↓ INC/DEC
            ↵ SAVE VALUE
 RANGE  AVG  DIAGS ALARM
```

Pressure Compensation

The Pressure Compensation screen is used to turn the pressure correction to actual or standard.

Note Pressure B settings please refer to Pressure as following description. ▲

- Press ↵ to toggle and set the pressure compensation to actual or standard.

```
PRESSURE:
>COMPENSATION          ACT
 STANDARD         760 mmHg



 RANGE  AVG  DIAGS ALARM
```

Standard

The Standard Pressure screen is used to set the standard pressure.

Note Pressure B settings please refer to Pressure as following description. ▲

- In the Main Menu, choose Instrument Controls > Volumetric Conditions > Pressure or Pressure B > **Standard**.

```
STANDARD PRESSURE:
 CURRENTLY:      760 mmHg
    SET TO:      760 mmHg ?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Datalogging Settings

The iSeries instruments include a built-in datalogging capability as a standard feature. The operator is allowed to create two different types of records, which for historical reasons, are named lrecs and srecs. Each record can contain up to 32 different fields, or data items, and records can be created at user-defined intervals ranging from 1 to 60 minutes.

Record generation is tied to the instrument's real-time clock. For example, if the logging period for srecs is set to 30 minutes, a new srec will be generated on every hour and every half hour (10:00, 10:30, 11:00 …). Lrecs and srecs function independent of each other. So, for example, an srec containing just the current PM level could be generated every 5 minutes while an lrec containing a full set of diagnostic data could be generated once every hour.

The analyzer's computer system includes three megabytes of flash memory which is enough to store a full lrec containing 32 data items and a full srec containing 32 items once each minute for a week (>20,000 total records). If logging is limited to the minimum content of date, time, PM concentration and error flags, the analyzer can store data once each minute for 4 months (>190,000 total records).

The Datalogging Settings menu allows the user flexibility in how data is stored and recorded.

- In the Main Menu, choose Instrument Controls > **Datalogging Settings**.

```
DATALOGGING:
>SELECT SREC/LREC    SREC
 VIEW LOGGED DATA
 ERASE LOG
 SELECT CONTENT
 COMMIT CONTENT
 RESET TO DEFAULT CONTENT
 CONFIGURE DATALOGGING   ↓

 RANGE  AVG  DIAGS ALARM
```

Select Srec/Lrec

The Select Srec/Lrec screen is used to select the log record type for other operations in this menu.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select Srec/Lrec**.

```
SELECT LOG TYPE:
 CURRENTLY:         SREC
    SET TO:         LREC ?

              ↵ TOGGLE VALUE

 RANGE  AVG  DIAGS ALARM
```

View Logged Data

The View Logged Data screen is used to select the starting point to view the logged data by the number of records or by date and time. Note that both types of records cannot be viewed at the same time, only the selected record type.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **View Logged Data**.

```
SELECT START POINT BY:
    SET TO: # OF RECS

  ↑↓ CHANGE    ↵ ACCEPT
 RANGE  AVG  DIAGS ALARM
```

Number of Records

The Number of Records screen is used to select the number of records to view, ending with the most recent. It also shows the total number of records that have been logged for the select record type.

```
SET # BACK FROM CURRENT:
                 0000000
TOTAL LRECS:          20

        ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE
 RANGE  AVG  DIAGS ALARM
```

The Record Display screen (read only) displays the selected records.

```
 time    date     flags
 10:01 01/20/07  8105151
 10:02 01/20/07  8105151
 10:03 01/20/07  8105151
 10:04 01/20/07  8105151
  ↑↓ PGUP/DN   ←→ PAN L/R

 RANGE  AVG  DIAGS ALARM
```

Date and Time

The Date and Time screen is used to set a start date and time for which to view logged data. For example, if "20 Jan 2007 10:00" is entered, then the first logged data record that is displayed is the first record after this time. If set to one minute logging, this would be at "20 Jan 2007 10:01".

```
DATE AND TIME:
 20 JAN 2007  10:00
 ↑↓ CHG   DAYS
 → SET CURSOR TO MONTHS
 ↵ ACCEPT AS SHOWN

 RANGE  AVG  DIAGS ALARM
```

The Record Display screen (read only) displays the selected records.

```
 time    date    flags
 10:01 01/20/07  8105151
 10:02 01/20/07  8105151
 10:03 01/20/07  8105151
 10:04 01/20/07  8105151
  ↑↓ PGUP/DN   ←→ PAN L/R

 RANGE  AVG  DIAGS ALARM
```

Erase Log

The Erase Log screen is used to erase all saved data for the selected record type only (not both srecs and lrecs).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Erase Log**.

```
ERASE LREC LOG FILE DATA?

                  ↵ ERASE



 RANGE  AVG  DIAGS ALARM
```

```
ERASE LREC LOG FILE DATA?

                ↵ ERASE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM ERASURE


 RANGE  AVG  DIAGS ALARM
```

Select Content

The Select Content submenu displays a list of 32 record fields to use to configure the data to be logged. When a field is selected, a submenu list appears of the items to choose from to assign to those fields. Item types are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed). These record fields comprise a temporary list of items for the selected record type that must be committed via the datalogging menu before the changes will apply. Note that committing any changes to this list will erase all currently logged data for the selected record type only, as the format of the stored data is changed.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Select Content**.

```
LREC FIELDS:
>FIELD 1              PM
 FIELD 2          AVG PM
 FIELD 3        FLOW VOL
 FIELD 4          AMB RH
 FIELD 5      BARO PRESS
 FIELD 6           PFLOW
 FIELD 7          PFLOWB ↓

 RANGE   AVG  DIAGS ALARM
```

Choose Field Data

The Choose Field Data submenu displays a list of the types of data that can be logged for the current field. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > **Field 1–32**.

```
DATA IN SREC FIELD  1:
>CONCENTRATIONS
 OTHER MEASUREMENTS




 RANGE   AVG  DIAGS ALARM
```

Concentrations

The Concentrations screen allows the user to assign one of the concentrations to the selected record field. The currently selected item is shown by "<--" after it. Note that at this point, pressing ↵ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below. The display shows the current heater for the mode selected (PM).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Concentrations**.

```
CONCENTRATIONS:
>NONE
 PM                      <--
 PMb
 AVG PM
 AVG PMb
 RANGE   AVG  DIAGS ALARM
```

Other Measurements

The Other Measurements screen allows the user to assign one of the other available measurement types to the selected record field. The currently selected item is shown by "<--" after it. Items displayed are determined by the options installed. For Common Flags and Detector A Flag, see Figure 3–5 and Figure 3–6 for data descriptions. Note that at this point, pressing ↵ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Other Measurements**.

```
OTHER MEASUREMENTS:
>NONE
 BARO PRES
 VACUUM
 VACUUM B
 FLOW PRES
 FLOW PRES B
 AMB RH                          ↓
 RANGE   AVG   DIAGS ALARM
```

```
 SAMP RH
 SAMP RH B
 AMB TEMP
 BRD TEMP
 FLOW TEMP
 FLOW TEMP B
 FLOW VOL
 FLOW VOL B
 BETA
 BETA  RAW
 ALPHA RAW
 MASS
 MASS B
 BETA ZERO
 BETA ZERO B
 BETA B
 BETA RAW B
 ALPHA RAW B
 BETA REF
 BETA REF B
 COMMON FLAGS
 DET  FLAGS
 DET B  FLAGS
 MASS COMP
 MASS COMP B
```

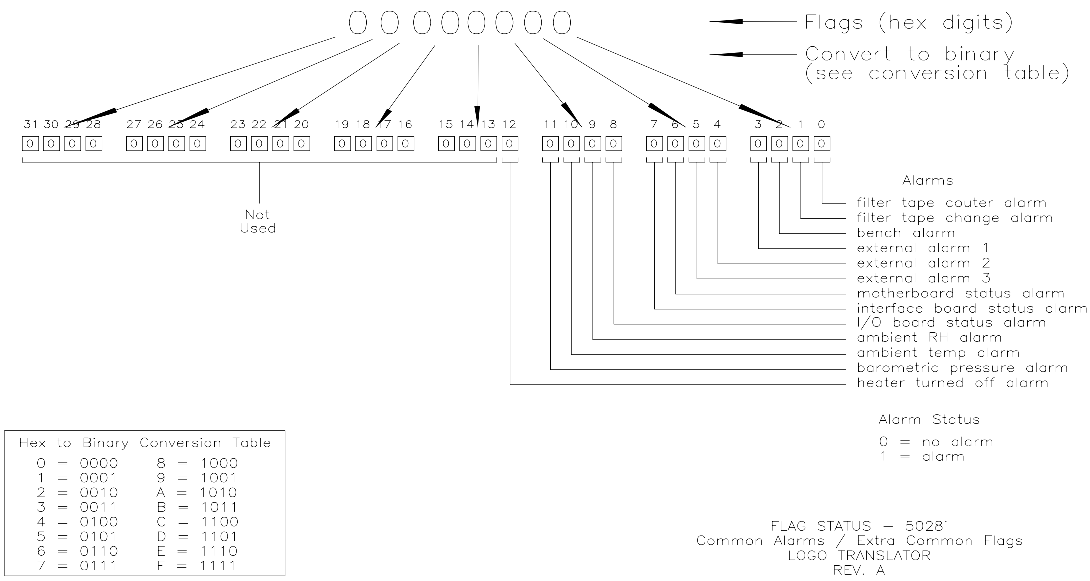


Figure 3–5. Common Flags

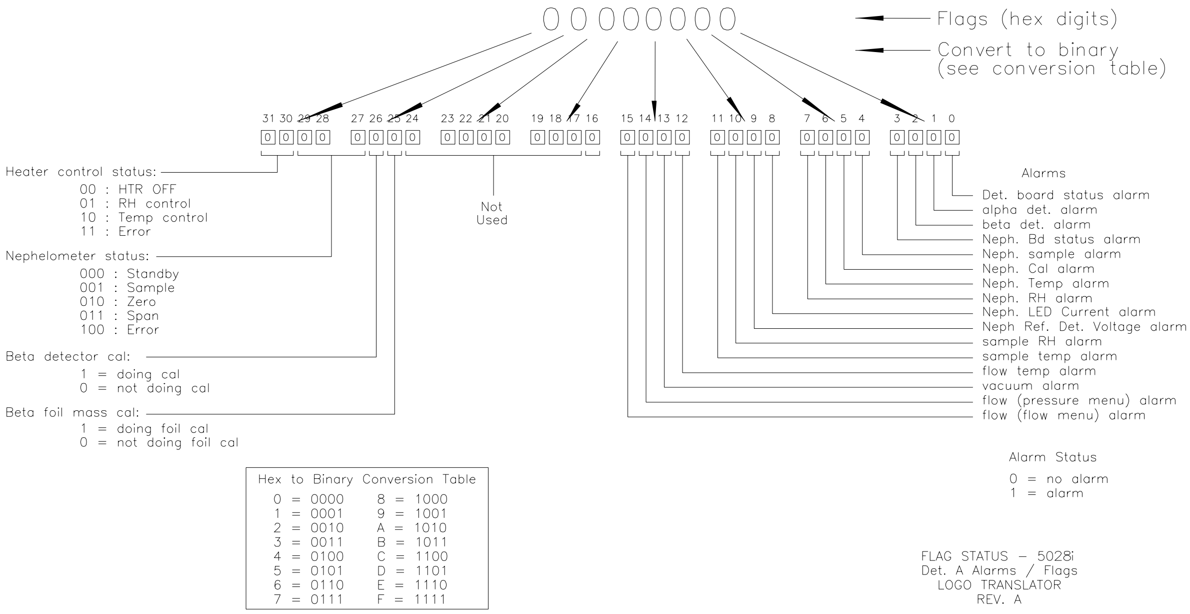


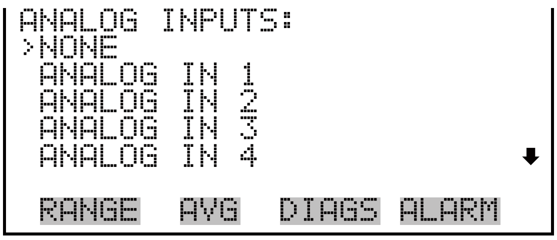
Figure 3–6. Detector A Flag

Analog Inputs

The Analog Inputs screen allows the user to select the parameter (none or analog inputs 1–8) to the selected record field. The selected item is shown by "<--" after it. Note that at this point, pressing ↵ indicates that these are proposed changes as opposed to implemented changes. To change the selected record format and erase record log file data, see "Commit Content" below.

Note The Analog Inputs is visible only if the I/O expansion board is installed. ▲

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Select Content > select Field > **Analog Inputs**.



Commit Content

The Commit Content screen is used to save any changes that have been made to any of the record fields for the selected record type. Saving changes will erase record log file data for that record type. If no changes have been made "NO CHANGES TO RECORD LIST!" will appear. For more information about selecting the content of logged data fields, see "Select Content" above.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Commit Content**.

```
CHANGE LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ COMMIT



 RANGE  AVG  DIAGS ALARM
```

```
CHANGE LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ COMMIT
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM ERASURE

 RANGE  AVG  DIAGS ALARM
```

Reset to Default Content

The Reset to Default Content screen is used to reset all of the datalogging record field items to default values for the selected record type. For more information about selecting the content of logged data fields, see "Select Content" above.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Reset to Default Content**.

```
RESET LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ RESET



 RANGE  AVG  DIAGS ALARM
```

```
RESET LREC DATA AND
ERASE LREC LOG FILE DATA?
                ↵ RESET
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM RESET

 RANGE  AVG  DIAGS ALARM
```

Configure Datalogging

The Configure Datalogging menu deals with datalogging configuration for the currently selected record type.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > **Configure Datalogging**.

```
DATALOGGING SETTINGS:
>LOGGING PERIOD MIN     60
 MEMORY ALLOCATION %    50
 DATA TREATMENT        AVG
 FLAG STATUS DATA       ON

 RANGE  AVG  DIAGS ALARM
```

Logging Period Min

The Logging Period Min screen is used to select the logging period in minutes for the selected record format (srec or lrec). List of choices include: off, 1, 5, 15, 30, and 60 minutes (default).

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Logging Period Min**.

```
SET PERIOD FOR SREC:
 CURRENTLY:        5 MIN
    SET TO:          OFF ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Memory Allocation Percent

The Memory Allocation Percent screen is used to select the percentage of total memory that may be used by the selected record type (lrecs or srecs). Percentages between 0 and 100% are available in increments of 10. Changing this value results in log erasure for both types of records, and changing the percent allocated to one record type will automatically change the other.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Memory Allocation %**.

```
SET PERCENT LRECS:
 CURRENTLY:          50%
    SET TO:          30% ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

```
SET PERCENT LRECS:
 CURRENTLY:          50%
    SET TO:          30% ?
THIS WILL ERASE ALL LOGS!
 PRESS ➡ TO CONFIRM CHANGE

 RANGE  AVG  DIAGS ALARM
```

Data Treatment

The Data Treatment screen is used to select the data type for the selected record type: whether the data should be averaged over the interval, the minimum or maximum measured during the interval, or the current value (last value measured). Data treatment doesn't apply to all data, just to the concentration measurement. All other data points log the current value at the end of the interval.

Note This feature is found in all iSeries instruments, but it is recommended that the data type be set to ONLY the current value (cur), as the datalogging averaging is done in addition to the normal concentration averaging. ▲

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Data Treatment**.

```
SET LREC DATA TYPE:
 CURRENTLY:  AVG
    SET TO:  CUR         ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Flag Status Data

The Flag Status Data screen is used to set the flag status data to either ON or OFF for the selected record type.

- In the Main Menu, choose Instrument Controls > Datalogging Settings > Configure Datalogging > **Flag Status Data**.

```
SET LREC FLAG STATUS DATA:
 CURRENTLY: OFF
    SET TO: ON          ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Communication Settings

The Communication Settings menu is used for communications control and configuration.

- In the Main Menu, choose Instrument Controls > **Communication Settings**.

```
COMMUNICATION SETTINGS:
>SERIAL SETTINGS
 INSTRUMENT ID
 GESYTEC SERIAL NO
 COMMUNICATION PROTOCOL
 STREAMING DATA CONFIG
 TCP/IP SETTINGS

 RANGE  AVG  DIAGS ALARM
```

Serial Settings

The Serial Setting submenu is used for serial communications control and configuration.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Serial Settings**.

```
SERIAL SETTINGS:
>BAUD RATE           9600
 DATA BITS              8
 PARITY              NONE
 STOP BITS              1
 RS-232/485 SEL    RS-232
 RANGE  AVG  DIAGS ALARM
```

Baud Rate

The Baud Rate screen is used to set the RS-232/RS-485 interface baud rate. Baud rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 are available. The analyzer's default baud rate is set to 9600 to provide backwards compatibility with the older C-series analyzers.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Baud Rate**.

```
BAUD RATE:
 CURRENTLY:          9600
    SET TO:         19200 ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Data Bits

The Data Bits screen is used to set the number of serial data bits to either 7 or 8 (default).

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Data Bits**.

```
DATA BITS:
 CURRENTLY:             8
    SET TO:             7 ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Parity

The Parity screen is used to select the parity bit for the serial port to None (default), Even, or Odd.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Parity**.

```
PARITY:
 CURRENTLY:          NONE
    SET TO:           ODD ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Stop Bits

The Stop Bits screen is used to set the number of stop bits for the serial port to 1 (default) or 2.

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **Stop Bits**.

```
STOP BITS:
 CURRENTLY:             1
    SET TO:             2 ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

RS-232/RS-485 Selection

The RS-232/RS-485 Selection screen allows the user to choose between the RS-232 or RS-485 specification for serial communication.

Equipment Damage Disconnect the serial cable before changing the RS-232 and RS-485 selection to prevent damage to any equipment currently connected to the analyzer. ▲

- In the Main Menu, choose Instrument Controls > Communication Settings > Serial Settings > **RS-232/485 Selection**.

```
RS-232/RS-485 SELECT:
      ** WARNING **
  DISCONNECT THE SERIAL
  CABLES BEFORE CHANGING
      THE SELECTION!
             ↵ TO CONTINUE

 RANGE  AVG  DIAGS ALARM
```

```
RS-232/RS-485 SELECT:
 CURRENTLY:        RS-232
    SET TO:        RS-485 ?
MAKE SURE THAT THE CABLE
IS OFF: PRESS ➡ TO CONFIRM
             ↵ TOGGLE VALUE

 RANGE  AVG  DIAGS ALARM
```

Instrument ID

The Instrument ID screen allows the operator to edit the instrument ID number. The ID is used to identify the instrument when using the C-Link or MODBUS protocols to control the instrument or collect data. It may be necessary to edit the ID number if two or more instruments of the same model are connected to one computer. Valid instrument ID numbers are from 0 to 127. The Model 5028*i* has a default instrument ID of 28. For more information about the instrument ID, see Appendix B “C-Link Protocol Commands” or Appendix C “MODBUS Protocol”.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Instrument ID**.

```
INSTRUMENT ID:
 CURRENTLY:            28
    SET TO:            28 ?

           ↑↓ CHANGE VALUE
            ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Gesytec Serial Number

The Gesytec Serial Number screen is used to set the serial number for the Gesytec protocol. The Gesytec serial number defaults to zero. For more information about the serial number, see Appendix D, “Gesytec (BH) Protocol”.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Gesytec Serial No.**

```
GESYTEC SERIAL NO:
 CURRENTLY:          0
    SET TO:          1 ?

          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Communication Protocol

The Communication Protocol screen is used to change the protocol for serial communications. Possible choices include:ESM, C-Link, MODBUS, Gesytec, and Streaming Data.

- In the Main Menu, choose Instrument Controls > Communication Settings > **Communication Protocol**.

```
COMMUNICATION PROTOCOL:
 CURRENTLY:        CLINK
    SET TO:    STREAMING ?

          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Streaming Data Configuration

The Streaming Data Configuration menu is used to allow for configuration of the 8 streaming data output items, streaming interval, current data format, and current timestamp setting. The Choose Stream Data submenu displays a list of the analog output signal group choices to choose from. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board option is installed).

- In the Main Menu, choose Instrument Controls > Communication Settings > **Streaming Data Config**.

```
STREAMING DATA CONFIG
>INTERVAL       10 SEC
 ADD LABELS         NO
 PREPEND TIMESTAMP YES
 ADD FLAGS         YES
 ITEM 1             PM
 ITEM 2             PM
 ITEM 3             PM ↓

 RANGE  AVG  DIAGS ALARM
```

Streaming Data Interval

The Streaming Data Interval screen is used to adjust how frequently a new record will be generated. The following interval times are available: 1, 2, 5, 10, 20, 30, 60, 90, 120, 180, 240, and 300 seconds.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Interval**.

```
STREAMING DATA INTERVAL:
 CURRENTLY:       10 SEC
    SET TO:       20 SEC ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Note Add Labels, Prepend Timestamp, and Add Flags are toggle items that change between yes or no when selected. ▲

Choose Stream Data

The Choose Stream Data screen displays a list of the types of data that can be sent via streaming data. Choices are Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board is installed).

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Item 1–16**.

```
CHOOSE STREAM DATA:
>CONCENTRATIONS
 OTHER MEASUREMENTS
 ANALOG INPUTS



 RANGE   AVG   DIAGS ALARM
```

Concentrations

The Concentrations screen allows the user to assign one of the concentrations to the selected streaming data item. The currently selected item is shown by “<--” after it. Once an item is selected, pressing ↵ will save the selected streaming data item.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > **Item 1–16** select Item > **Concentrations**.

```
CONCENTRATIONS:
>NONE
 PM                    <--
 PMb
 AVG PM
 AVG PMb
 RANGE   AVG   DIAGS ALARM
```

Other Measurements

The Other Measurements screen allows the user to assign one of the other available measurement types to the selected streaming data item. The currently selected item is shown by “<--” after it. Once an item is selected, pressing ↵ will save the selected streaming data item. For Common Flags and Detector A Flags, see Figure 3–5 and Figure 3–6 for data descriptions.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > select Item > **Other Measurements**.

```
OTHER MEASUREMENTS:
>NONE
 BARO PRES
 VACUUM
 VACUUM B
 FLOW PRES
 FLOW PRES B
 AMB RH                       ↓
 RANGE  AVG  DIAGS ALARM
  SAMP RH
  SAMP RH B
  AMB TEMP
  BRD TEMP
  FLOW TEMP
  FLOW TEMP B
  FLOW VOL
  FLOW VOL B
  BETA
  BETA  RAW
  ALPHA RAW
  MASS
  MASS B
  BETA ZERO
  BETA ZERO B
  BATE B
  BETA REF
  BETA REF B
  COMMON FLAGS
  DET  FLAGS
  DET B FLAGS
  MASS COMP B
  MASS COMP
```

Analog Inputs

The Analog Inputs screen allows the user to assign an analog input signal (none or analog inputs 1–8) to the selected streaming data item. The currently selected item is shown by "<--" after it. Once an item is selected, pressing ↵ will save the selected streaming data item.

- In the Main Menu, choose Instrument Controls > Communication Settings > Streaming Data Config > select Item > **Analog Inputs**.

```
ANALOG INPUTS:
>NONE
 ANALOG IN 1
 ANALOG IN 2
 ANALOG IN 3
 ANALOG IN 4
 ANALOG IN 5
 ANALOG IN 6                  ↓

 RANGE  AVG  DIAGS ALARM
```

TCP/IP Settings

The TCP/IP Settings menu is used for defining parameters that are required for Ethernet communications.

Note The instrument power must be cycled after any of these parameters have been changed for the change to take effect. ▲

- In the Main Menu, choose Instrument Controls > Communication Settings > **TCP/IP Settings**.

```
TCP/IP SETTINGS:
>USE DHCP              OFF
 IP ADDR       10.68.179.67
 NETMASK      255.255.254.0
 GATEWAY        10.68.178.1
 HOST NAME          iSeries
 NTP SVR            0.0.0.0

 RANGE  AVG  DIAGS ALARM
```

Use DHCP

The Use DHCP screen is used to specify whether to use Dynamic Host Configuration Protocol (DHCP) or not. When DHCP is enabled, the network dynamically provides an IP address for the instrument.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Use DHCP**.

```
DHCP:
 CURRENTLY:           OFF
    SET TO:            ON ?

            ↵ TOGGLE VALUE
CYCLE POWER TO CHANGE DHCP

 RANGE  AVG  DIAGS ALARM
```

IP Address

The IP Address screen is used to edit the IP address. The IP address can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" above.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **IP Addr**.

```
IP ADDRESS:
 CURRENT: 10.68.179.67
  SET TO: 10.68.179.67  █
          ←→ MOVE CURSOR
          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Netmask

The Netmask screen is used to edit the netmask. The netmask is used to determine the subnet on which the instrument can directly communicate to other devices. The netmask can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" above.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Netmask**.

```
NETMASK:
 CURRENT: 255.255.252.0
  SET TO: 255.255.254.0
          ←→ MOVE CURSOR
          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Default Gateway

The Default Gateway screen is used to edit the gateway address. The default gateway can only be changed when DHCP is off. If DHCP is on, the instrument will respond with "NOT SETTABLE IF DHCP IS ON". For more information on DHCP, see "Use DHCP" above. Any traffic to addresses that are not on the local subnet will be routed through this address.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Gateway**.

```
DEFAULT GATEWAY:
 CURRENT: 10.209.42.1
  SET TO: 10.68.178.1
          ←→ MOVE CURSOR
          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Host Name

The Host Name screen is used to edit the host name. When DHCP is enabled, this name is reported to the DHCP server.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **Host Name**.

```
HOST NAME:
  CURRENT: ISERIES
           ISERIES      ?
  ABCDEFGHIJKLMN      BKSP
  OPQRSTUVWXYZ        PAGE
  0123456789 ./-      SAVE

 RANGE  AVG  DIAGS ALARM
```

Network Time Protocol Server

The Network Time Protocol (NTP) Server screen is used to edit the IP address of the NTP server. An NTP server may be used to periodically synchronize the instrument's real-time clock with a standard. More information about the NTP servers and a list of public servers may be found at http://www.ntp.org.

- In the Main Menu, choose Instrument Controls > Communication Settings > TCP/IP Settings > **NTP Svr**.

```
NTP SERVER IP ADDRESS:
 CURRENT: 0.0.0.0
  SET TO: 0.0.0.0
          ←→ MOVE CURSOR
          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

I/O Configuration

The I/O Configuration menu deals with configuration of the analyzer's I/O system. The analog input configuration is displayed only if the I/O expansion board option is installed.

- In the Main Menu, choose Instrument Controls > **I/O Configuration**.

```
I/O CONFIGURATION:
>OUTPUT RELAY SETTINGS
 DIGITAL INPUT SETTINGS
 ANALOG OUTPUT CONFIG
 ANALOG INPUT CONFIG

 RANGE  AVG  DIAGS ALARM
```

Note The Analog input config screen is visible only when the I/O expansion board option is installed and the service mode is on . For more information on the service mode, see "Service Mode" earlier in "Program Versions Voltages". ▲

Output Relay Settings

The Output Relay Settings menu displays a list of the 10 digital output relays available, and allows the user to select the logic state and instrument parameter for the relay selected.

Note The digital outputs may take up to one second after the assigned state occurs to show up on the outputs. ▲

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Output Relay Settings**.

```
OUTPUT RELAY SETTINGS:
>1   NOP      CONC ALARM
 2   NOP    LOCAL/REMOTE
 3   NOP           UNITS
 4   NOP       GEN ALARM
 5   NOP            NONE ↓

 RANGE  AVG  DIAGS ALARM
```

Logic State

The Logic State menu item is used to change the selected I/O relay to either normally open or normally closed. The default state is open, which indicates that a relay connected between the digital output pin and ground is normally open and closes to trigger the digital output action.

- Press ↵ to toggle and set the logic state to normally open or normally closed.

```
OUTPUT RELAY SETUP:
>LOGIC STATE         OPEN
 INSTRUMENT STATE




 RANGE  AVG  DIAGS ALARM
```

Instrument State

The Instrument State submenu allows the user to select the instrument state that is assigned to the selected relay output. A submenu lists signal types of either alarms or non-alarm to choose from.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > select Relay > **Instrument State**.

```
CHOOSE SIGNAL TYPE:
>ALARMS
 NON-ALARM




 RANGE  AVG  DIAGS ALARM
```

Alarms

The Alarms screen allows the user to select an alarm status for the selected relay output. The currently selected item is shown by "<--" after it. The I/O board status alarm is only present if the I/O expansion board is installed.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > select Relay > Instrument State > **Alarms**.

```
ALARM STATUS ITEMS:
>NONE
 GEN ALARM
 CONC ALARM          <--
 INST ALARMS
 DET ALARMS             ↓
 RH/TEMP ALARMS
 PRES/VAC ALARMS

 RANGE  AVG  DIAGS ALARM
```

```
 FLOW ALARMS
 FIL TAPE COUNT
 FIL TAPE CHANGE
 BATE
 AMBIENT  RH
 SAMPLE  RH
 AMBIENT TEMP
 FLOW TEMP
 BARO  PRES
 VACUUM
 FLOW
 FIL TAPE COUNT B
 FIL TAPE CHANGE B
 BETA B
 SAMPLE RH B
 FLOW TEMP B
 VACUUM B
 FLOW B
```

Non-Alarm

The Non-Alarm screen allows the user to select a non-alarm status for the selected relay output. The currently selected item is shown by "<--" after it.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Output Relay Settings > select Relay > Instrument State > **Non-Alarm**.

```
NON ALARM STATUS ITEMS:
>NONE
 LOCAL/REMOTE
 SERVICE
 UNITS
 MODE A
 MODE B
 MODE AB                ↓

 RANGE  AVG  DIAGS ALARM
```

```
 FLAG A
 FLAG B
```

Digital Input Settings

The Digital Input Settings menu displays a list of the 16 digital inputs available, and allows the user to select the logic state and instrument parameter for the relay selected.

Note The digital inputs must be asserted for at least one second for the action to be activated. ▲

Not all of the I/O available in the instrument are brought out on the supplied terminal board. If more I/O is desired, an alternative means of connection is required. (See optional "Terminal Block and Cable Kits".) ▲

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Digital Input Settings**.

```
DIGITAL INPUT SETTINGS:
>1    NOP          MODE A
 2    NOP    AOUTS TO ZERO
 3    NOP       PUMP CNTRL
 4    NOP       PRES CNTRL
 5    NOP             NONE
 6    NOP             NONE
 7    NOP             NONE ↓

 RANGE  AVG  DIAGS ALARM
```

Logic State

The Logic State menu item is used to change the selected I/O relay to either normally open or normally closed. The default state is open, which indicates that a relay connected between the digital input pin and ground is normally open and closes to trigger the digital input action.

- Press ↵ to toggle and set the logic state to normally open or normally closed.

```
DIGITAL INPUT SETUP:
>LOGIC STATE          OPEN
 INSTRUMENT ACTION



 RANGE  AVG  DIAGS ALARM
```

Instrument Action

The Instrument Action submenu allows the user to choose the instrument action that is assigned to the selected digital input.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Digital Input Settings > select Relay > **Instrument Action**.

```
CHOOSE ACTION:
>NONE
 MODE A                  <--
 MODE B
 MODE AB
 AOUTS TO ZERO
 AOUTS TO FS
 FT COUNT                  ↓
 RANGE  AVG  DIAGS ALARM
```

```
FT CNTRL
PUMP CNTRL
TEMP CNTRL
PRES CNTRL
HT CNTRL
RH/TEMP CNTRL
HT CNTRL B
RH/TEMP CNTRL  B
EXT ALARM 1
EXT ALARM 2
EXT ALARM 3
FT COUNT B
FTCNTRL B
```

Analog Output Configuration (Select Channel)

The Analog Output Configuration menu displays a list of the analog output channels available for configuration. Channel choices include all voltage channels, all current channels, individual voltage channels 1–6, and individual current channels 1–6 (if the I/O expansion board option is installed).

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Output Config**.

```
OUTPUT CHANNELS:
>ALLOW OVER/UNDER RANGE
 ALL VOLTAGE CHANNELS
 VOLTAGE CHANNEL 1
 VOLTAGE CHANNEL 2
 VOLTAGE CHANNEL 3         ↓
 RANGE  AVG  DIAGS ALARM
```

Allow Over/Under Range

The Allow Over/Under Range screen is used to select whether or not the analog outputs are allowed to exceed the maximum selected value of 100 mV, 1 V, 5 V, 10 V, or 20 mA or the minimum selected value of 0 V, 0 mA, or 4 mA. By default, this parameter is set to on and 5% over and under range is allowed for all analog output channels.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > **Allow Over/Under Range**.

```
ALLOW OVER/UNDER RANGE:
 CURRENTLY:          ON
    SET TO:         OFF  ?

           ↵ TOGGLE VALUE

 RANGE  AVG  DIAGS ALARM
```

Analog Output Configuration (Select Action)

The Analog Output Configuration menu displays a list of the analog output configuration choices, from which the user selects the parameter to adjust for the selected output channel. Configuration choices include selecting range, setting minimum/maximum values, and choosing the signal to output.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > **All Voltage Channels, All Current Channels, Voltage Channel 1–6** or **Current Channel 1–6**.

```
ANALOG OUTPUT CONFIG:
>SELECT RANGE
 SET MINIMUM VALUE
 SET MAXIMUM VALUE
 CHOOSE SIGNAL TO OUTPUT

 RANGE  AVG  DIAGS ALARM
```

Select Range

The Select Range screen is used to select the hardware range for the selected analog output channel. Possible ranges for the voltage outputs are: 0-100 mV, 0-1, 0-5, and 0-10 V. Possible ranges for the current outputs are: 0-20 mA and 4-20 mA.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > select Channel > **Select Range**.

```
SELECT OUTPUT RANGE:
 SELECTED OUTPUT:  V ALL
 CURRENTLY:        0-10V
    SET TO:      0-100mV ?
 ↑↓ CHANGE VALUE   ↵ SAVE
 RANGE  AVG  DIAGS ALARM
```

Minimum and Maximum Value

The Minimum and Maximum Value screens are used to edit the zero (0) and full-scale (100) values, respectively, in percentages for the selected analog output channel. See Table 3–4 for a list of choices. The minimum and maximum output value screens function the same way. The following example shows the set minimum value screen.

- In the Main Menu, choose Instrument Controls > IO Configuration > Analog Output Config > select Channel > **Set Minimum** or **Maximum Value**.

```
MINIMUM OUTPUT PERCENT:
 SELECTED OUTPUT:   V ALL
 CURRENTLY:         N/A
    SET TO:       0000.0 % ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Table 3–4. Analog Output Zero to Full-Scale

Output	Zero (0)% Value	Full-Scale 100% Value
PM	Zero (0)	Range Setting
AVG PM	Zero (0)	Range Setting
Barometer Pressure	User-set alarm min value	User-set alarm max value
Vacuum	User-set alarm min value	User-set alarm max value
Flow Pressure	User-set alarm min value	User-set alarm max value
Ambient RH	User-set alarm min value	User-set alarm max value
Sample RH	User-set alarm min value	User-set alarm max value
Ambient Temp	User-set alarm min value	User-set alarm max value
Board Temp	User-set alarm min value	User-set alarm max value
Flow Temp	User-set alarm min value	User-set alarm max value
Flow Vol	User-set alarm min value	User-set alarm max value
Beta	User-set alarm min value	User-set alarm max value
Beta Raw	User-set alarm min value	User-set alarm max value
Alpha Raw	User-set alarm min value	User-set alarm max value
Mass	-200	5,000
Beta Zero	0	65,000
External Alarms	0	7,000
Beta Ref	0	65,000

Choose Signal to Output

The Choose Signal to Output screen displays a list of the analog output signal choices. Choices are grouped into three categories: Concentrations, Other Measurements, and Analog Inputs (if the I/O expansion board option is installed). This allows the user to select the output signal that will be assigned to each analog channel. The Concentrations screen is shown below. See Table 3–5 for a list of items for each signal group choice.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Output Config > select Channel > **Choose Signal to Output**.

```
CHOOSE SIGNAL TYPE:
>CONCENTRATIONS
 OTHER MEASUREMENTS
 ANALOG INPUTS


 RANGE  AVG  DIAGS ALARM
```

```
CHOOSE SIGNAL -    CONC
 SELECTED OUTPUT:    V1
 CURRENTLY: PM
    SET TO: NONE          ?

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Note The Analog input config screen is visible only when the I/O expansion board option is installed and the service mode is on . For more information on the service mode, see "Service Mode" earlier in "Program Versions Voltages". ▲

Table 3–5. Signal Type Group Choices

Concentrations	Other Measurements	Analog Inputs
None	None	None
PM	Barometer Pressure	Analog Input 1 (if the I/O expansion board is installed)
AVG PM	Vacuum	Analog Input 2 (if the I/O expansion board is installed)
	Flow Pressure	Analog Input 3 (if the I/O expansion board is installed)
	Ambient RH	Analog Input 4 (if the I/O expansion board is installed)
	Sample RH	Analog Input 5 (if the I/O expansion board is installed)
	Ambient Temp	Analog Input 6 (if the I/O expansion board is installed)
	Board Temp	Analog Input 7 (if the I/O expansion board is installed)

Concentrations	Other Measurements	Analog Inputs
	Flow Temp	Analog Input 8 (if the I/O expansion board is installed)
	Flow Vol	
	Beta	
	Beta Raw	
	Alpha Raw	
	Mass	
	Beta Zero	
	External Alarms	
	Beta Ref	
	Common Flags	
	Det A Flags	

Analog Input Configuration

The Analog Input Configuration menu displays a list of the 8 analog input channels available for configuration. This screen is only displayed if the I/O expansion board option is installed. Configuration includes entering the Descriptor, Units, Decimal Places, choice of 1–10 points in the table, and corresponding number of points selected.

- In the Main Menu, choose Instrument Controls > I/O Configuration > **Analog Input Config**.

```
ANALOG INPUT CONFIG:
>CHANNEL 1                 IN1
 CHANNEL 2                 IN2
 CHANNEL 3                 IN3
 CHANNEL 4                 IN4
 CHANNEL 5                 IN5
 CHANNEL 6                 IN6
 CHANNEL 7                 IN7↓

 RANGE   AVG   DIAGS  ALARM
```

```
ANALOG INPUT 01 CONFIG:
>DESCRIPTOR                IN1
 UNITS                       V
 DECIMAL PLACES              2
 TABLE POINTS                2
 POINT 1
 POINT 2                     ↓

 RANGE   AVG   DIAGS  ALARM
```

Note The Analog input config screen is visible only when the I/O expansion board option is installed and the service mode is on . For more information on the service mode, see "Service Mode" earlier in "Program Versions Voltages". ▲

Descriptor

The Descriptor screen allows the user to enter the descriptor, or name, for the selected analog input channel. The descriptor is used in datalogging and streaming data to report what data is being sent out. The descriptor may be from 1 to 3 characters in length, and defaults to IN1 to IN8 (user input channel number).

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > **Descriptor**.

```
ANALOG INPUT DESCRIPTOR:
 CURRENTLY: IN1
            IN1
 ABCDEFGHIJKLMN      BKSP
 OPQRSTUVWXYZ        PAGE
 0123456789 ./-      SAVE

 RANGE   AVG   DIAGS ALARM
```

Units

The Units screen allows the user to enter the units for the selected analog input channel. The units are displayed on the diagnostic screen and in datalogging and streaming data. The units may be from 1 to 3 characters in length, and defaults to V (volts).

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > **Units**.

```
ANALOG INPUT UNITS:
 CURRENTLY: V
            V
 ABCDEFGHIJKLMN      BKSP
 OPQRSTUVWXYZ        PAGE
 0123456789 ./-      SAVE

 RANGE   AVG   DIAGS ALARM
```

Decimal Places

The Decimal Places screen allows the user to select how many digits are displayed to the right of the decimal point, from 0 to 6, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > **Decimal Places**.

```
DECIMAL PLACES:
 CURRENTLY:            2
    SET TO:            3 ?

           ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Number of Table Points

The Number of Table Points screen allows the user to select how many points are used in the analog input conversion table for the selected channel. The instrument uses linear interpolation between the points in this table to determine what the reading value is based on the analog input voltage. Each point in the table consists of an analog input voltage value (0–10.5 V) and a corresponding reading value. Only two points are necessary for linear inputs, however a larger number of points may be used to approximate non-linear inputs. The points range from 2 to 10, with a default of 2.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > **Table Points**.

```
NUMBER OF TABLE POINTS:
 CURRENTLY:            2
    SET TO:           10 ?

            ↑↓ INC/DEC
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Table Points

The Table Point submenu allows the user to set up an individual table point.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > **Point 1–10**.

```
TABLE POINT 01 CONFIG:
>VOLTS                0.00
 USER VALUE           0.00



 RANGE  AVG  DIAGS ALARM
```

Volts

The Volts screen allows the user to set the input voltage for the selected table point in the conversion table, from 0.00 to 10.50. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U, where U is the previously entered unit of measure.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > select Point > **Volts**.

```
TABLE POINT 01 VOLTS:
 CURRENTLY:         0.00
    SET TO:        00.00

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

User Value

The User Value screen allows the user to set the output value for the corresponding input voltage for the selected table point in the conversion table, from -9999999 to 99999999. The default table is a two-point table with point 1: 0.00 V = 000.0 U and point 2: 10.00 V = 10.0 U, where U is the previously entered unit of measure.

- In the Main Menu, choose Instrument Controls > I/O Configuration > Analog Input Config > select Channel > select Point > **User Value**.

```
TABLE POINT 01 USER VAL:
 CURRENTLY:          0.00
    SET TO:      00000.00

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Screen Contrast

The Screen Contrast screen is used to change the contrast of the display. Intensities between 0 and 100% in increments of 5 are available. Changing the screen contrast may be necessary if the instrument is operated at extreme temperatures.

Note The optimal contrast will change with changes in temperature. ▲

Note The optimal contrast will change from one LCD to another. If the LCD is replaced, the contrast may need to be reset. ▲

If the display contrast is not optimal, but the content on the screen is visible, select Instrument Controls > **Screen Contrast** and adjust the screen contrast. If the content on the screen is not visible, use the "set contrast 10" C-Link command to set the screen contrast to mid-range, then optimize the contrast. See "contrast levels" in Appendix B, "C-Link Protocol Commands" for more information on this command. ▲

- In the Main Menu, choose Instrument Controls > **Screen Contrast**.

```
SCREEN CONTRAST:
 CURRENTLY:         50 %
    SET TO:         55 % ?

          ↑↓ CHANGE VALUE
           ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Service Mode

The Service Mode screen is used to turn the service mode on or off. Turning service mode "ON" locks out any remote actions and allows access to parameters and functions that are useful when making adjustments or diagnosing the Model 5028*i*. The service (wrench) icon on the status bar is shown when service mode is on. For more information about the service mode, see "Service Menu" later in this chapter.

Note The service mode should be turned off when finished, as it prevents remote operation. ▲

- In the Main Menu, choose Instrument Controls > **Service Mode**.

```
SERVICE MODE:
 CURRENTLY:          OFF
    SET TO:           ON ?

            ← TOGGLE VALUE
 RANGE   AVG   DIAGS ALARM
```

Date/Time

The Date/Time screen allows the user to view and change the system date and time (24-hour format). The internal clock is powered by its own battery when instrument power is off.

- In the Main Menu, choose Instrument Controls > **Date/Time**.

```
DATE AND TIME:
 19 MAR 2005  12:34:56
 PRESS ↵ TO EDIT



 RANGE   AVG   DIAGS ALARM
```

```
DATE AND TIME:
 19 MAR 2005  12:34:56   ?
 SETTING: DAYS
            → SET MONTHS
           ↑↓ CHANGE VALUE
            ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Timezone

The Timezone screen is used to set the timezone for the Network Time Protocol (NTP) server. This should be set to the timezone that the instrument is located in. If the exact timezone is not shown in the list, it may be entered via the C-LINK "tz" command (see Appendix B). The selections are: UTC (GMT), EST (GMT+5), CST (GMT+6), MST (GMT+7), PST (GMT+8), YST (GMT+9), HST (GMT+10), NST (GMT+11), DLW (GMT+12), CET (GMT-1), EET (GMT-2), BST (GMT-3), DLT (GMT-4), ECH (GMT-5), FOX (GMT-6), GLF (GMT-7), CCT (GMT-8), JST (GMT-9), GST (GMT-10), LMA (GMT-11), DLE (GMT-12), EDT (GMT+5/4), CDT (GMT+6/5), MDT (GMT+7/6), and PDT (GMT+8/7).

Note The current timezone may say NULL before the timezone is set for the first time, or if the timezone was cleared with a C-Link command. ▲

- In the Main Menu, choose Instrument Controls > **Timezone**.

```
TIMEZONE FOR TIMESERVER:
 CURRENTLY: UTC (GMT)
    SET TO: EST (GMT+5)  ?

            ↑↓ CHANGE VALUE
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Diagnostics Menu

The Diagnostics menu provides access to diagnostic information and functions. This menu is useful when troubleshooting the instrument. The analog input readings and analog input voltages are only displayed if the I/O expansion board option is installed.

- In the Main Menu, choose **Diagnostics**.

```
DIAGNOSTICS:
>PROGRAM VERSIONS
 VOLTAGES
 RH/TEMPERATURE
 PRESSURE/VACUUM
 FLOW
 DETECTOR STATUS
 CRn                        ↓

 RANGE  AVG  DIAGS ALARM

 ANALOG INPUT READINGS
 ANALOG INPUT VOLTAGES
 DIGITAL INPUTS
 RELAY STATES
 TEST ANALOG OUTPUTS
 INSTRUMENT CONFIGURATION
 CONTACT INFORMATION
```

Program Versions

The Program Versions screen (read only) shows the version numbers of the programs installed. Prior to contacting the factory with any questions regarding the instrument, please note the product model name and the program version numbers.

- In the Main Menu, choose Diagnostics > **Program Versions**.

```
PROGRAM VERSIONS:
   PRODUCT:   MODEL 5028i
   VERSION: 02.03.02.279+
  FIRMWARE:     11.62.161
    B/AMPL:      03.00.31

 RANGE  AVG  DIAGS ALARM
```

Voltages

The Voltages menu displays the current diagnostic voltage readings. This screen enables the power supply to be quickly read for low or fluctuating voltages without having to use a voltage meter. The I/O board item is only displayed if the I/O expansion board option is installed.

- In the Main Menu, choose Diagnostics > **Voltages**.

Note The I/O Board screen is visible only when the I/O expansion board option is installed. ▲

```
VOLTAGES:
>MOTHERBOARD
 INTERFACE BOARD
 I/O BOARD
 DETECTOR BOARD

 RANGE  AVG  DIAGS ALARM
```

Motherboard Voltages

The Motherboard screen (read only) is used to display the voltage readings on the motherboard.

- In the Main Menu, choose Diagnostics > Voltages > **Motherboard**.

```
MOTHERBOARD VOLTAGES:
   3.3 SUPPLY       3.3 V
   5.0 SUPPLY       5.0 V
  15.0 SUPPLY      15.0 V
  24.0 SUPPLY      24.1 V
  -3.3 SUPPLY      -3.3 V

 RANGE  AVG  DIAGS ALARM
```

Interface Board Voltages

The Interface Board screen (read only) is used to display the voltage readings on the measurement interface board.

- In the Main Menu, choose Diagnostics > Voltages > **Interface Board**.

```
INTERFACE BOARD VOLTAGES:
  >3.3 SUPPLY       3.3 V
   5.0 SUPPLY       5.0 V
  15.0 SUPPLY      15.0 V
  24.0 SUPPLY      24.0 V
 -15.0 SUPPLY     -15.0 V
  5.0 BATTERY       5.0 V

 RANGE  AVG  DIAGS ALARM
```

I/O Board Voltages

The I/O Board screen (read only) is used to display the voltage readings on the I/O expansion board. This menu is only displayed if the I/O expansion board option is installed.

- In the Main Menu, choose Diagnostics > Voltages > **I/O Board**.

```
I/O BOARD VOLTAGES:
   3.3 SUPPLY          3.3 V
   5.0 SUPPLY          5.0 V
  24.0 SUPPLY         24.0 V
  -3.3 SUPPLY         -3.3 V

 RANGE  AVG  DIAGS ALARM
```

Detector Board Voltages

The Detector Board screen (read only) is used to display the voltage readings on the measurement interface board.

- In the Main Menu, choose Diagnostics > Voltages > **Detector Board**.

```
DETECTOR BOARD:
 5.0 SUPPLY            5.0 V

 RANGE  AVG  DIAGS ALARM
```

RH/Temperature

The RH/Temperature screen (read only) displays the current relative humidity and temperature readings. The board temperature is the air temperature measured by a sensor located on the measurement interface board.

- In the Main Menu, choose Diagnostics > **RH/Temperature**.

```
RH/TEMPERATURES:
>AMBIENT RH          40.0  %
 SAMPLE RH           36.4  %
 SAMPLE RH  B        36.4  %
 AMBIENT TEMP        22.9  °C
 FLOW TEMP           23.9  °C
 FLOW TEMP  B        23.9  °C
 BOARD TEMP          24.9  °C

 RANGE  AVG  DIAGS ALARM
```

Pressure/Vacuum

The Pressure/Vacuum screen (read only) displays the current pressure readings. The pressure is measured by a pressure transducer. The vacuum is the amount of vacuum under the filter tape. The flow pressure is the pressure differential across the orifice.

- In the Main Menu, choose Diagnostics > **Pressure/Vacuum**.

```
PRESSURE/VACUUM:
 BAROMETRIC     760.1  mmHg
 VACUUM          60.5  mmHg
 FLOW            21.5  mmHg
 VACUUM B        60.5  mmHg
 FLOW   B        21.5  mmHg

 RANGE   AVG   DIAGS  ALARM
```

Flow

The Flow screen (read only) displays the current sample flow reading. The flow is measured by the internal pressure board sensors.

Note Flow B settings please refer to Flow as following description. ▲

- In the Main Menu, choose Diagnostics > **Flow**.

```
 FLOW:              16.67 LPM
 FLOW   B:          16.67 LPM


 RANGE   AVG   DIAGS  ALARM
```

Detector Status

The Detector Status screen (read only) displays the current sample mass reading, alpha counts, and beta counts.

Note A mass value will only be calculated when the flowrate is within acceptable limits. However, when in Service Mode, a mass value will be calculated if the pump is turned OFF. ▲

Note Detector B settings please refer to Detector as following description. ▲

- In the Main Menu, choose Diagnostics > **Detector Status**.>**Detector status or Detector status B**

```
DETECTOR STATUS:
 MASS                  0 ug
 ALPHA                 2 1/sec
 BETA              13577 1/sec
 BETA CORR         13577 1/sec
 BETA ZERO          6500 1/sec
 RANGE   AVG   DIAGS  ALARM
```

CRn

The CRn screen (read only) displays the current CRn reading.

- In the Main Menu, choose Diagnostics > **CRn or CRn B**.

```
CRn               0.00 Bq/m3
CRn   B           0.00 Bq/m3



RANGE   AVG   DIAGS ALARM
```

Analog Input Readings

The Analog Input Readings screen (read only) displays the 8 user-scaled analog readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Readings**.

```
ANALOG INPUT READINGS:
 IN1                  0.00 V
 IN2                  0.00 V
 IN3                  0.00 V
 IN4                  0.00 V
 IN5                  0.00 V
 IN6                  0.00 V↓

 RANGE   AVG   DIAGS ALARM
```

Analog Input Voltages

The Analog Input Voltages screen (read only) displays the 8 raw analog voltage readings (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Analog Input Voltages**.

```
ANALOG INPUT VOLTAGES:
>IN 1                6.24 V
 IN 2                4.28 V
 IN 3                0.00 V
 IN 4                0.00 V
 IN 5                0.00 V
 IN 6                0.00 V
 IN 7                0.00 V↓

 RANGE   AVG   DIAGS ALARM
```

Digital Inputs

The Digital Inputs screen (read only) displays the state of the 16 digital inputs. Pull-ups are provided on all of the inputs, so if nothing they will read (1), if an input is brought to ground, it will read (0).

- In the Main Menu, choose Diagnostics > **Digital Inputs**.

```
DIGITAL INPUTS:
>INPUT 1                  1
 INPUT 2                  1
 INPUT 3                  1
 INPUT 4                  1
 INPUT 5                  1
 INPUT 6                  1
 INPUT 7                  1↓

 RANGE   AVG   DIAGS ALARM
```

Relay States

The Relay States screen displays the state of the 10 digital outputs and allows toggling of the state to either on (1) or off (0). The relays are restored to their original states upon exiting this screen.

- In the Main Menu, choose Diagnostics > **Relay States**.
- Press ↵ to toggle and set the relay state to open or closed for the selected digital output.

```
RELAY STATE:
>OUTPUT 1              0
 OUTPUT 2              0
 OUTPUT 3              0
 OUTPUT 4              1
 OUTPUT 5              1
 OUTPUT 6              1
 OUTPUT 7              1↓

 RANGE  AVG  DIAGS ALARM
```

Test Analog Outputs

The Test Analog Outputs menu is used to set each of the analog output channels to zero or full-scale. Channel choices include all analog outputs, 6 voltage channels, and 6 current channels (if the I/O expansion board option is installed).

- In the Main Menu, choose Diagnostics > **Test Analog Outputs**.

```
TEST ANALOG OUTPUTS:
>ALL
 VOLTAGE CHANNEL 1
 VOLTAGE CHANNEL 2
 VOLTAGE CHANNEL 3
 VOLTAGE CHANNEL 4
 VOLTAGE CHANNEL 5
 VOLTAGE CHANNEL 6↓

 RANGE  AVG  DIAGS ALARM
```

Set Analog Outputs

The Set Analog Outputs screen contains three choices: Set to full-scale, set to zero, or reset to normal. Full-scale sets the analog outputs to the full-scale voltage, zero sets the analog outputs to 0 volts, and reset returns the output to normal operation. The analog outputs are returned to normal operation upon exiting this screen. The following example shows the screen when all analog outputs are set to “normal” operating mode.

- In the Main Menu, choose Diagnostics > Test Analog Outputs > **ALL, Voltage Channel 1–6**, or **Current Channel 1–6**.

```
SET ANALOG OUTPUTS:
 SETTING:             ALL
 OUTPUT SET TO:    NORMAL
 ↑ SET TO FULL SCALE
 ↓ SET TO ZERO
 ← RESET TO NORMAL

 RANGE  AVG  DIAGS ALARM
```

Instrument Configuration

The Instrument Configuration screen displays information on the hardware configuration of the instrument.

Note If the analyzer is in service mode, pressing [↵] will toggle the selected item between yes and no. ▲

- In the Main Menu, choose Diagnostics > **Instrument Configuration**.

```
INSTRUMENT CONFIGURATION:
>I/O EXPANSION BOARD YES
 DETECTOR           BETA
 DETECTOR B         BETA

 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Contact Information

The Contact Information screen displays the customer service information.

- In the Main Menu, choose Diagnostics > **Contact Information**.

```
CONTACT INFORMATION:

 CALL CENTER: 508-520-0430

 http://WWW.THERMO.COM/AQI

 RANGE  AVG  DIAGS ALARM
```

Alarms Menu

The alarms menu allows the user to view a set of alarms for different boards and displays a list of items that are monitored by the analyzer. The number of alarms detected is displayed to indicate how many alarms have occurred. If no alarms are detected, the number zero is displayed.

If the item being monitored goes outside the lower or upper limit, the status of that item will go from "OK" to either "LOW" or "HIGH", respectively. If the alarm is not a level alarm, the status will go from "OK" to "FAIL". The number of alarms detected is displayed to indicate how many alarms have occurred. If no alarms are detected, the number zero is displayed.

Items displayed are determined by the options installed. To see the actual reading of an item and its minimum and maximum limits, move the cursor to the item and press ↵. If the readings go beyond either the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

If any alarms are active, the alarm (bell) icon is displayed on the right side of the status bar.

- In the Main Menu, choose **Alarms**.

```
ALARMS:
 ALARMS DETECTED          0
>INSTRUMENT ALARMS        0
 DETECTOR ALARMS          0
 RH/TEMPERATURE ALARMS    0
 PRESSURE/VACUUM ALARMS   0
 FLOW ALARMS              0
 CONC ALARMS              0

 RANGE  AVG  DIAGS ALARM
```

Instrument Alarms

The Instrument Alarms submenu allows the user to view a set of alarms for different boards. The filter tape change, heater power, and bench items (motherboard, interface board and I/O expansion board) are read only. The motherboard status, interface board status, and I/O expansion board status (if installed) indicate that the power supplies are working and connections are successful. There are no setting screens for these alarms.

- In the Main Menu, choose Alarms > **Instrument Alarms**.

```
INSTRUMENT ALARMS:
>FILTER TAPE COUNTER    OK
 FILTER TAPE CHANGE     OK
 BENCH                  OK
 HEATER POWER           OK
 MOTHERBOARD STATUS     OK
 INTERFACE STATUS       OK
 I/O EXP STATUS         OK↓

 RANGE  AVG  DIAGS ALARM

 FILTER TAPE COUNTER B
 FILTER TAPE CHANGE B
 BENCH B
 HEATER POWER B
```

Filter Tape Counter

The Filter Tape Counter screen displays the current filter tape counter value and sets the maximum alarm limit. If the filter tape counter reading goes beyond the maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Instrument Alarms > **Filter Tape Counter**.

```
FILTER TAPE COUNTER:
 ACTUAL                0
>MAX                1300



 RANGE  AVG  DIAGS ALARM
```

Max Filter Tape Counter

The Maximum Filter Tape Counter screen is used to change the maximum filter tape counter alarm limit (1200 = 90% usage, 10% remaining).

- In the Main Menu, choose Alarms > Instrument Alarms > Filter Tape Counter > **Max**.

```
FILTER TAPE COUNTER:
 ACT MAX:            450
 SET MAX:           1300  ?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ← SAVE
 RANGE  AVG  DIAGS ALARM
```

Detector Alarms

The Detector Alarms submenu allows the user to view a set of alarms for detector boards. Board status indicates that the power supplies are working and connections are successful. There are no setting screens for this alarm.

- In the Main Menu, choose Alarms > **Detector Alarms**.

```
DETECTOR ALARMS:
 BOARD STATUS          OK
 BOARD STATUS  B       OK
>ALPHA                 OK
 ALPHA B               OK
 BETA                  OK
 BETA B
 RANGE  AVG  DIAGS ALARM
```

Min and Max Alpha Alarms

The Alpha Alarms screen allows the user to view the minimum and maximum alarm parameters. Acceptable alarm limits range from 0 to 100. If the alpha count reading goes beyond the maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and and in the Main Menu

Note Alpha B settings please refer to Alpha as following description. ▲

- In the Main Menu, choose Alarms > Detector Alarms > **Alpha or Alpha B**.

```
ALPHA COUNT:
 ACTUAL                 0
 MIN                    0
 MAX                  100



 RANGE  AVG  DIAGS ALARM
```

Min and Max Beta Alarms

The Beat Alarms screen allows the user to view the minimum and maximum alarm parameters. Acceptable alarm limits range from 5000 to 20000. If the beta count reading goes beyond the maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

Note Beta B settings please refer to Beta as following description. ▲

- In the Main Menu, choose Alarms > Detector Alarms > **Beta or Beta B**.

```
BETA COUNT:
 ACTUAL                 0
 MIN                 5000
 MAX                20000



 RANGE  AVG  DIAGS ALARM
```

RH/Temperature Alarms

The RH/Temperature Alarms submenu allows the user to view and set the relative humidity or temperature alarm parameters.

- In the Main Menu, choose Alarms > **RH/Temperature Alarms**.

```
RH/TEMPERATURE ALARMS:
>AMBIENT RH           OK
 SAMPLE  RH           OK
 SAMPLE  RH  B        OK
 AMBIENT TEMP         OK
 FLOW TEMP            OK
 FLOW TEMP B          OK
 BOARD TEMP           OK↓
 RANGE  AVG  DIAGS ALARM
```

Ambient RH

The Ambient RH screen displays the current ambient relative humidity value and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 5 to 95%. If the ambient RH reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > RH/Termperature Alarms > **Ambient RH**.

```
AMBIENT RH:
 ACTUAL              27.4 %
>MIN                  5.0 %
 MAX                 95.0 %


 RANGE  AVG  DIAGS ALARM
```

Min and Max Ambient RH Limits

The Minimum Ambient RH alarm limit screen is used to change the minimum ambient RH alarm limit. The minimum and maximum ambient RH screens function the same way.

- In the Main Menu, choose Alarms > RH/Temperature Alarms > Ambient RH > **Min** or **Max**.

```
RELATIVE HUMIDITY:
 ACT MIN:             5.0 %
 SET MIN:             5.5 %?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Sample RH/Sample RH B

The Sample RH screen displays the current sample relative humidity value and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 5 to 95%. If the sample RH reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

Note Sample RH B settings please refer to Smaple RH as following description. ▲

- In the Main Menu, choose Alarms > RH/Termperature Alarms > **Sample RH or Sample RH**.

```
SAMPLE RH:
 ACTUAL              0.0  %
>MIN                 5.0  %
 MAX                95.0  %


 RANGE  AVG  DIAGS ALARM
```

Min and Max Sample RH Limits

The Minimum Sample RH alarm limit screen is used to change the minimum ambient RH alarm limit. The minimum and maximum sample RH screens function the same way.

- In the Main Menu, choose Alarms > RH/Temperature Alarms > Sample RH or Sample RH B > **Min** or **Max**.

```
SAMPLE RH:
 ACT MIN:              5.0 %
 SET MIN:              35 %?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Ambient Temperature

The Ambient Temperature screen displays the current ambient temperature value and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -30 °C to 60 °C. If the ambient temperature reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > RH/Termperature Alarms > **Ambient Temp**.

```
AMBIENT TEMP:
 ACTUAL           -30.0 °C
>MIN              -30.0 °C
 MAX               60.0 °C


 RANGE  AVG  DIAGS ALARM
```

Min and Max Ambient Temperature Limits

The Minimum Ambient Temperature alarm limit screen is used to change the minimum ambient temperature alarm limit. The minimum and maximum ambient temperature screens function the same way.

- In the Main Menu, choose Alarms > RH/Temperature Alarms > Ambient Temp > **Min** or **Max**.

```
AMBIENT TEMPERATURE:
 ACT MIN:         -30.0 °C
 SET MIN:         -20.0 °C?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Flow Temperature

The Flow Temperature screen displays the current ambient temperature value and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 5 to 60 °C. If the flow temperature reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu

Note Flow Temp B settings please refer to Flow Temp as following description. ▲

- In the Main Menu, choose Alarms > RH/Termperature Alarms > **Flow Temp or Flow Temp B**.

```
FLOW TEMP:
 ACTUAL              24.4  °C
>MIN                  0.0  °C
 MAX                 60.0  °C



 RANGE   AVG   DIAGS ALARM
```

Min and Max Flow Temperature Limits

The Minimum Flow Temperature alarm limit screen is used to change the minimum flow temperature alarm limit. The minimum and maximum flow temperature screens function the same way.

- In the Main Menu, choose Alarms > RH/Temperature Alarms > Flow Temp or Flow Temp B > **Min** or **Max**.

```
FLOW TEMPERATURE:
 ACT MIN:              0.0  °C
 SET MIN:              5.5  °C?

            ↑↓ INC/DEC
             ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Board Temperature

The Board Temperature screen displays the current board temperature value and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 5 to 60 °C. If the board temperature reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > RH/Termperature Alarms > **Board Temp**.

```
BOARD TEMP:
 ACTUAL              26.1  °C
>MIN                  0.0  °C
 MAX                 60.0  °C



 RANGE   AVG   DIAGS ALARM
```

Min and Max Board Temperature Limits

The Minimum Board Temperature alarm limit screen is used to change the minimum board temperature alarm limit. The minimum and maximum board temperature screens function the same way.

- In the Main Menu, choose Alarms > RH/Temperature Alarms > Board Temp > **Min** or **Max**.

```
BOARD TEMPERATURE:
 ACT MIN:          5.0 °C
 SET MIN:          0.0 °C?

           ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Pressure/Vacuum Alarms

The Pressure/Vacuum Alarms submenu allows the user to view and set the pressure alarm parameters.

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms.

```
PRESSURE/VACUUM ALARMS:
>BARO PRES             OK
 VACUUM                OK
 VACUUM  B             OK
 FLOW                  OK
 FLOW  B               OK

 RANGE  AVG  DIAGS ALARM
```

Barometric Pressure

The Barometric Pressure screen displays the current pressure reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 400 to 840 mmHg. If the barometric pressure reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > **Baro Pres**.

```
BAROMETRIC PRESSURE:
 ACTUAL        764.0 mmHg
>MIN           400.0 mmHg
 MAX           840.0 mmHg


 RANGE  AVG  DIAGS ALARM
```

Min and Max Barometric Pressure Limits

The Minimum Barometric Pressure alarm limit screen is used to change the minimum barometric pressure alarm limit. The minimum and maximum barometric pressure screens function the same way.

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > Baro Pres > **Min** or **Max**.

```
BAROMETRIC PRESSURE:
 ACT MIN:       400.0 mmHg
 SET MIN:       400.1 mmHg?

            ↑↓ INC/DEC
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Vacuum

The Vacuum screen displays the current vacuum reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -5 mmHg to 250 mmHg. If the vacuum reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu

Note Vacuum B settings please refer to Vaccum as following description. ▲

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > **Vacuum or Vacuum B**.

```
VACUUM:
 ACTUAL          60.8 mmHg
>MIN             -5.0 mmHg
 MAX            250.0 mmHg



 RANGE  AVG  DIAGS ALARM
```

Min and Max Vacuum Limits

The Minimum Vacuum alarm limit screen is used to change the minimum vacuum alarm limit. The minimum and maximum vacuum screens function the same way.

Note The maximum vacuum value should not be changes, as this is also used as a protective feature for the instrument. ▲

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > Vacuum or Vacuum B > **Min** or **Max**.

```
VACUUM:
 ACT MIN:        -5.0 mmHg
 SET MIN:        -4.9 mmHg?

            ↑↓ INC/DEC
             ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Flow

The Flow screen displays the current flow reading and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -5 mmHg to 40 mmHg. If the flow reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu

Note Flow B settings please refer to Flow as following description. ▲

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > **Flow or Flow B**.

```
FLOW:
 ACTUAL         23.1 mmHg
>MIN            -5.0 mmHg
 MAX            40.0 mmHg


 RANGE  AVG  DIAGS ALARM
```

Min and Max Flow Limits

The Minimum Flow alarm limit screen is used to change the minimum flow alarm limit. The minimum and maximum flow screens function the same way.

- In the Main Menu, choose Alarms > Pressure/Vacuum Alarms > Flow or Flow B > **Min** or **Max**.

```
FLOW PRESSURE:
 ACT MIN:       -5.0 mmHg
 SET MIN:       -4.9 mmHg?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Flow Alarms

The Flow Alarms submenu allows the user to view and set the flow alarm parameters.

- In the Main Menu, choose Alarms > **Flow Alarms**.

```
FLOW ALARMS:
>FLOW                  OK
 FLOW B                OK



 RANGE  AVG  DIAGS ALARM
```

Flow

The Flow screen displays the current flow and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 16.00 to 17.34 LPM. If the flow reading goes beyond the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

Note Flow B settings please refer to Flow as following description. ▲

- In the Main Menu, choose Alarms > Flow Alarms > **Flow or Flow B**.

```
FLOW:
 ACTUAL            0.00 LPM
>MIN              16.17 LPM
 MAX              17.17 LPM


 RANGE   AVG   DIAGS ALARM
```

Min and Max Flow Limits

The Minimum Flow alarm limit screen is used to change the minimum flow alarm limit. The minimum and maximum flow screens function the same way.

- In the Main Menu, choose Alarms > Flow Alarms > Flow or Flow B > **Min** or **Max**.

```
FLOW:
 ACT MIN:         16.00 LPM
 SET MIN:         16.17 LPM?

             ↑↓ INC/DEC
              ↵ SAVE VALUE
 RANGE   AVG   DIAGS ALARM
```

Concentration Alarms

The Concentration Alarms submenu allows the user to view and set the 24-hour average PM and instant PM concentration alarm parameters.

- In the Main Menu, choose Alarms > **Conc Alarms**.

```
CONC ALARMS:
>AVG PM                  OK
 AVG PMb                 OK
 INST PM                 OK
 INST PMb                OK

 RANGE   AVG   DIAGS ALARM
```

Average PM/PM_b

The Average PM screen displays the current average PM concentration and sets the minimum and maximum alarm limits. Acceptable alarm limits range from 0 to 10000 μg/m^3 or 0 to 10 mg/m^3. If the average PM concentration goes beyond either the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

Note Avg PM_b settings please refer to Avg PM as following description. ▲

- In the Main Menu, choose Alarms > Conc Alarms > **Avg PM/Avg PM_b**.

```
AVERAGE PM CONC:
 ACTUAL                    0.0
>MIN                       0.0
 MAX                     10000



 RANGE   AVG   DIAGS  ALARM
```

Min and Max Average PM/PM_b Concentration Limits

The Minimum Average PM/PM_b Concentration alarm limit screen is used to change the minimum average PM/PM_b concentration alarm limit. The minimum and maximum average PM/PM_b concentration screens function the same way.

- In the Main Menu, choose Alarms > Conc Alarms > Avg PM or Avg PM_b > **Min** or **Max**.

```
AVERAGE PM CONC:
 ACT MIN:                 0.0
 SET MIN:                 100 ?

               ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE       ↵ SAVE

 RANGE   AVG   DIAGS  ALARM
```

Instant PM/Instant PM_b

The Instant PM screen displays the current instant PM/PM_b concentration and sets the minimum and maximum alarm limits. Acceptable alarm limits range from -10 to 10000 μg/m^3 or -.01 to 10 mg/m^3. If the instant PM/PM_b concentration goes beyond either the minimum or maximum limit, an alarm is activated and the alarm (bell) icon appears in the status bar on the Run screen and in the Main Menu.

Note Instant PM_b settings please refer to Instant PM as following description. ▲

- In the Main Menu, choose Alarms > Conc Alarms > **Inst PM or Inst PM_b**.

```
INSTANT PM CONC:
 ACTUAL                0.0
>MIN                 -10.0
 MAX                 10000


 RANGE  AVG  DIAGS ALARM
```

Min and Max Instant PM Concentration Limits

The Minimum Instant PM/PM_b Concentration alarm limit screen is used to change the minimum instant PM/PM_b concentration alarm limit. The minimum and maximum instant PM/PM_b concentration screens function the same way.

- In the Main Menu, choose Alarms > Conc Alarms > Inst PM or Inst PM_b > **Min** or **Max.**

```
INSTANT PM CONC:
 ACT MIN:             0.0
 SET MIN:             -10 ?

             ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Service Menu

The Service menu appears only when the instrument is in the service mode. When the service mode is active, the service (wrench) icon is displayed on the right side of the status bar. To put the instrument into the service mode:

- In the Main Menu, choose Instrument Controls > **Service Mode**.

Advanced diagnostic functions are included in the service mode. Meaningful data should not be collected when the instrument is in the service mode.

- In the Main Menu, choose **Service**.

```
SERVICE:
>RH/TEMP CALIBRATION
 PRES/VACUUM CALIBRATION
 FLOW CALIBRATION
 MASS CALIBRATION
 DETECTOR CALIBRATION
 ANALOG OUT CALIBRATION
 ANALOG INPUT CALIBRATION↓

 RANGE  AVG  DIAGS ALARM

 LANGUAGE
 DISPLAY PIXEL TEST
 RESTORE USER DEFAULTS
 RESTORE FACTORY DEFAULTS
```

RH/Temperature Calibration

The RH/Temperature Calibration submenu allows the user to view and set the relative humidity and temperature sensor calibration. The RH/temperature calibration submenu is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in this chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **RH/Temp Calibration**.

```
RH/TEMP CALIBRATION:
>AMBIENT TEMP        4.2  °C
 FLOW TEMP           0.8  °C
 FLOW TEMP B         0.8  °C
 AMBIENT RH          0.0  %


 RANGE  AVG  DIAGS ALARM
```

Ambient Temperature

The Ambient Temperature screen allows the user to view and calibrate ambient temperature. Adjust the zero offset until the ambient temperature agrees with your treaceable standard.

- In the Main Menu, choose Service > RH/Temp Calibration > **Ambient Temp**.

```
CALIBRATE AMBIENT TEMP:
 TEMPERATURE:       29.9  °C
      OFFSET:        4.2  °C

             ↑↓ INC/DEC
              ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Flow/Flow B Temperature

The Flow/Flow B Temperature screen allows the user to view and calibrate flow/flow B temperature. Be sure to have the cover removed and equilibrated to room temperature.

Note Flow B Temperature settings please refer to Flow Temperature as following description. ▲

- In the Main Menu, choose Service > RH/Temp Calibration > **Flow Temp/ Flow Temp B**.

```
CALIBRATE FLOW TEMP:
 TEMPERATURE:       28.0  °C
      OFFSET:        0.8  °C

             ↑↓ INC/DEC
              ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Ambient Relative Humidity

The Ambient Relative Humidity screen allows the user to view and calibrate relative humidity. Adjust the zero offset until the RH agrees with your treaceable standard.

- In the Main Menu, choose Service > RH/Temp Calibration > **Ambient RH**.

```
CALIBRATE AMBIENT RH:
 REL HUMIDITY:     40.0 %
       OFFSET:      0.0 %

              ↑↓ INC/DEC
               ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Pressure/Vacuum Calibration

The Pressure/Vacuum Calibration submenu allows the user to view and calibrate the pressure sensor and vacuum flow sensor. The pressure/vacuum calibration submenu is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Pres/Vacuum Calibration**.

```
PRES/VACUUM CALIBRATION:
>BARO PRES
 VAC/FLOW
 VAC/FLOW B



 RANGE  AVG  DIAGS ALARM
```

Barometer Pressure Calibration

The Barometer Pressure Calibration submenu is used to calibrate the barometer pressure span or reset default values.

- In the Main Menu, choose Service > Pres/Vacuum Calibration > **Baro Pres**.

```
BARO PRES CALIBRATION:
>OFFSET              0.0
 SPAN                1.0000
 SET DEFAULTS



 RANGE  AVG  DIAGS ALARM
```

Calibrate Barometer Pressure Span

The Calibrate Barometer Pressure Span screen allows the user to view and pressure sensor calibration span point.

Note The operator should use an independent barometer to measure the ambient pressure and enter the value on this screen before calibrating. ▲

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Baro Pres Calibration > **Span**.

```
CAL BARO PRESSURE SPAN:
 PRESSURE:        760 mmHg
   SET TO:        747 mmHg?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Restore Default Calibration

The Restore Default Calibration screen allows the user to reset the default values.

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Baro Pres Calibration > **Set Defaults**.

```
RESTORE DEFAULT CAL:

                ↵ RESTORE



 RANGE  AVG  DIAGS ALARM
```

```
RESTORE DEFAULT CAL:

                ↵ RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

 RANGE  AVG  DIAGS ALARM
```

Vacuum/Flow or Vacuum/ Flow B Calibration

The Vacuum/Flow or Vaccum/Flow B Calibration submenu are used to calibrate the vacuum/flow zero, vacuum/flow span, or reset default values.

Note Vac/Flow B settings please refer to Vac/Flow as following description. ▲

- In the Main Menu, choose Service > Pres/Vacuum Calibration > **Vac/Flow or Vac/Flow B**.

```
VAC PRES CALIBRATION:
>VAC/FLOW OFFSET
 VAC  PRES SPAN     1.0000
 FLOW PRES SPAN     1.0000
 SET DEFAULTS


 RANGE  AVG  DIAGS ALARM
```

Calibrate Vacuum/Flow Offset

The Calibrate Vacuum/Flow Offset screen calibrates the vacuum/flow sensor at zero value.

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Vac/Flow Offset**.

```
CAL VACUUM/FLOW OFFSET:
 VAC  OFFSET:          0.0
 FLOW OFFSET:          0.0

 ↵ TO CALIBRATE ZERO BY
      CHANGING FILTER

 RANGE  AVG  DIAGS ALARM
```

Calibrate Vacuum Pressure Span

The Calibrate Vacuum Pressure Span screen allows the user to view and set the flow sensor calibration span point.

Note The operator should use an independent manometer capable of measuring approximately 100 mmHg of vacuum. Measure the vacuum under the filter tape from the positive ΔP port on the rear panel of the instrument and enter the value on this screen before calibrating. ▲

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Vac Pres Span**.

```
CAL VAC PRESSURE SPAN:
 VACUUM:          58.7 mmHg
 SET TO:          60.0 mmHg?

           ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Calibrate Flow Pressure Span

The Flow Pressure Span screen allows the user to view and set the flow sensor calibration span point.

Note The operator should use an independent manometer, capable of 30 mmHg ΔP, to measure the differential pressure across the orifice using the positive and negative ΔP ports on the rear panel, and enter the value on this screen before calibrating. ▲

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Flow Pres Span**.

```
CAL FLOW PRESSURE SPAN:
 FLOW:            21.0 mmHg
 SET TO:          20.0 mmHg?

           ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Restore Default Calibration

The Restore Default Calibration screen allows the user to reset the default values.

Note Be sure to close the toggle switch after calibration is complete. ▲

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Set Defaults**.

```
RESTORE DEFAULT CAL:

                ↵ RESTORE



 RANGE   AVG   DIAGS ALARM
```

```
RESTORE DEFAULT CAL:

                ↵ RESTORE
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM RESTORE


 RANGE   AVG   DIAGS ALARM
```

Flow Calibration

The Flow Calibration submenu is used to view and set the flow calibration flow point. The flow calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see “Service Mode” earlier in the chapter.

Note Flow Span B settings please refer to Flow Span as following description. ▲

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Flow Calibration>Flow Span or Flow Span B**.

```
FLOW CALIBRATION:
>AUTO
 MANUAL




 RANGE   AVG   DIAGS ALARM
```

Auto Flow Calibration

The Auto Flow Calibration screen allows the user to view and set the correct flow rate. The span value is automatically calculated.

- In the Main Menu, choose Service > Flow Calibration > Flow Span or Flow Span **B>Auto**.

```
FLOW AUTO CALIBRATION:
   FLOW:          16.67 LPM
 SET TO:          17.23 LPM?

         ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Manual Flow Calibration

The Manual Flow Calibration screen allows the user to view and incrementally set the flow sensor calibration span factor.

- In the Main Menu, choose Service > Flow Calibration > Flow Span or Flow Span **B> Manual**.

```
FLOW MANUAL CALIBRATION:
 FLOW:              16.67
 SPAN:              0.750  ?

            ↑↓ INC/DEC
          ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Mass Calibration

The Mass Calibration submenu is used to view and set the mass calibration point. The mass calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in the chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

Note Mass Calibration B settings please refer to Mass Calibration as following description. ▲

- In the Main Menu, choose Service > **Mass Calibration> Mass Calibration or Mass Calibration B.**

```
MASS CALIBRATION:
>THERMAL    COEFFICIENT
 VACUUM     COEFFICIENT
 BARO       COEFFICIENT
 MASS       COEFFICIENT
 ALPHA EFF  COEFFICIENT

 RANGE  AVG  DIAGS ALARM
```

Thermal Mass Coefficient

The Thermal Mass Coefficient screen allows the user to view and set the thermal coefficient using manual calibration mode.

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B> Thermal Coefficient.**

```
THERMAL MASS COEFFICIENT:
 CURRENTLY:      0.000000
    SET TO:      0019.000 ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Vacuum Mass Coefficient

The Vacuum Mass coefficient screen allows the user to view and set the vacuum coefficient using manual calibration mode.

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B> Vacuum Coefficient**.

```
VACUUM MASS COEFFICIENT:
 CURRENTLY:      0.000000
    SET TO:      0002.000 ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Barometer Mass Coefficient

The Barometer Mass Coefficient screen allows the user to view and set the barometer coefficient using manual calibration mode.

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B> Baro Coefficient**.

```
BARO. MASS COEFFICIENT:
 CURRENTLY:      0.000000
    SET TO:      0.000540 ?

            ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Mass Coefficient

The Mass Coefficient submenu allows the user to view and set the mass coefficient using manual or auto mode.

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B> Mass Coefficient**.

```
MASS COEFFICIENT:
>AUTO
 MANUAL




 RANGE   AVG   DIAGS ALARM
```

Auto Mass Coefficient

The Auto Mass Coefficient screen allows the user to conduct a mass foil calibration.

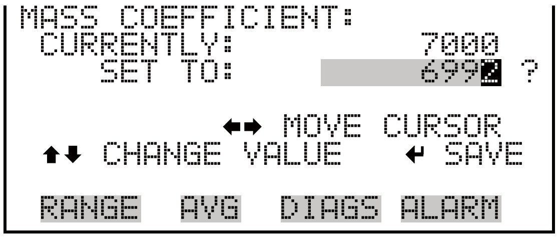
Note After pressing ↵ a series of screens will walk you through the mass foil calibration procedure. For details, see "Auto Mass Coefficient" on page 4-8 Bookmark not defined. ▲

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B>** Mass > **Auto**.

Manual Mass Coefficient

The Manual Mass Coefficient screen allows the user to adjust the mass coefficient used in beta attenuation.

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B>** Mass > **Manual**.

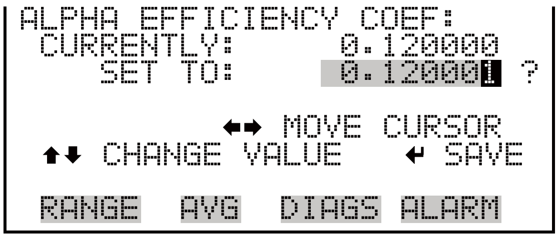


Alpha Efficiency Coefficient

The Alpha Efficiency Coefficient screen allows the user to view and set the alpha efficiency value.

Note This value is set in the factory and should not be adjusted. ▲

- In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B> Alpha Eff Coefficient**.



Detector Calibration

The Detector Calibration submenu is used to view and set the detector calibration. The detector calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in the chapter.

Note Detector Calibration B settings please refer to Detector Calibration as following description. ▲

Note This adjustment should only be performed by an instrument service technician on a defined service interval and at least once per year, or if the detector is replaced. ▲

- In the Main Menu, choose Service > **Detector Calibration> Detector Calibration or Detector Calibration B**.

```
DETECTOR CALIBRATION:
>AUTO
 MANUAL



 RANGE   AVG   DIAGS ALARM
```

Auto Detector Calibration

The Auto Detector Calibration screen allows the user to conduct a detector optimization routine that will establish the optimal plateau for detector performance. This process takes approximately 30 minutes and will set a high voltage and thresholds for alpha and beta reference counts.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B>Auto**.

```
DETECTOR AUTO CAL:
 HIGH VOLT:     1500 V
 BETA CNT :    14649 1/sec

PRESS ↵ TO START AUTO CAL
 RANGE   AVG   DIAGS ALARM
```

Manual Detector Calibration

The Mass Coefficient submenu allows the user to perform a mass foil calibration using a zero (null) and span foil set.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B> Manual**.

```
DETECTOR MANUAL CAL:
>BETA/REF/ALPHA COUNTS
 HIGH VOLTAGE
 BETA REF THRESHOLD
 ALPHA THRESHOLD


 RANGE  AVG  DIAGS ALARM
```

Beta/Ref/Alpha Counts

The Beta/Ref/Alpha Counts screen allows the user to view the real-time alpha and beta counts.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B**> Manual > **Beta/ Ref/Alpha Counts**.

```
COUNTS:
 alpha           0 1/sec
 beta        10212 1/sec
 beta corr   10145 1/sec
 beta ref     5200 1/sec


RANGE  AVG  DIAGS ALARM
```

High Voltage

The High Voltage screen allows the user to view and set the high voltage value.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B**> Manual > **High Voltage**.

```
HIGH VOLTAGE:
 CURRENTLY:        1500 V
    SET TO:        1501 V?

           ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Beta Ref Threshold

The Beta Ref Threshold screen allows the user to view and set the detector operating voltage manually.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B**> Manual > **Beta Ref Threshold.**

```
REF BETA THRESHOLD:
 CURRENTLY:          500
    SET TO:          501 ?

           ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Alpha Threshold

The Alpha Threshold screen allows the user to view and set the alpha threshold manually.

- In the Main Menu, choose Service > Detector Calibration >> **Detector Calibration or Detector Calibration B**> Manual > **Alpha Threshold**.

```
ALPHA THRESHOLD:
 CURRENTLY:          1500
    SET TO:          1501 ?

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE   AVG   DIAGS ALARM
```

Analog Output Calibration

The Analog Output Calibration menu provides access to the 6 voltage channels and 6 current channels for calibration. Current channels are visible only if the I/O expansion board is installed. The analog output calibration menu is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Out Calibration**.

```
ANALOG OUTPUT CAL:
>VOLTAGE CHANNEL 1
 VOLTAGE CHANNEL 2
 VOLTAGE CHANNEL 3
 VOLTAGE CHANNEL 4
 VOLTAGE CHANNEL 5
 VOLTAGE CHANNEL 6
 CURRENT CHANNEL 1        ↓

 RANGE   AVG   DIAGS ALARM
```

```
ANALOG OUTPUT CAL:
>CALIBRATE ZERO
 CALIBRATE FULL SCALE




 RANGE   AVG   DIAGS ALARM
```

Analog Output Calibrate Zero

The Analog Output Calibrate Zero screen allows the user to calibrate the zero state of the selected analog output. The operator must connect a volt meter to the output and adjust the output until it reads 0.0 V on the meter for a voltage channel, or either 0 or 4 mA for a current channel (depending on the selected range). See the "set output to:" field on the display.

- In the Main Menu, choose Service > Analog Out Cal > select Channel > **Calibrate Zero**.

```
ANALOG OUTPUT CAL:    ZERO
 CONNECT METER TO OUTPUT!
  SELECTED OUTPUT:     V1
  SET TO:             100
 ↵ SAVE VALUE   ↑↓ INC/DEC
 SET OUTPUT TO:     0.0 V

 RANGE   AVG   DIAGS ALARM
```

Analog Output Calibrate Full-Scale

The Analog Output Calibrate Full-Scale screen allows the user to calibrate the full-scale state of the selected analog output. The operator must connect a volt meter to the output and adjust the output until the meter reads the value shown in the "set output to:" field, in either V or mA, depending on the selected output channel.

- In the Main Menu, choose Service > Analog Out Cal > select Channel > **Calibrate Full Scale**.

```
ANALOG OUTPUT CAL:    SPAN
 CONNECT METER TO OUTPUT!
  SELECTED OUTPUT:     V1
  SET TO:            3397
 ↵ SAVE VALUE   ↑↓ INC/DEC
 SET OUTPUT TO:      10 V

 RANGE   AVG   DIAGS ALARM
```

Analog Input Calibration

The Analog Input Calibration menu is used to calibrate the 8 analog input channels at both zero and full-scale. The analog input calibration menu is visible only when the I/O expansion board is installed and when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Analog Input Calibration**.

```
ANALOG INPUT CAL:
>INPUT CHANNEL 1
 INPUT CHANNEL 2
 INPUT CHANNEL 3
 INPUT CHANNEL 4
 INPUT CHANNEL 5
 INPUT CHANNEL 6
 INPUT CHANNEL 7              ↓

 RANGE  AVG  DIAGS ALARM
```

```
ANALOG INPUT CAL:
>CALIBRATE ZERO
 CALIBRATE FULL SCALE





 RANGE  AVG  DIAGS ALARM
```

Analog Input Calibrate Zero

The Analog Input Calibrate Zero screen allows the user to calibrate the zero state of the selected analog input.

- In the Main Menu, choose Service > Analog Input Cal > select Channel > **Calibrate Zero**.

```
ANALOG INPUT CAL:      ZERO
DISCONNECT SELECTED INPUT!
 SELECTED INPUT:   INPUT 1
 CURRENTLY:         0.04 V

 ↵ CALIBRATE INPUT TO ZERO

 RANGE  AVG  DIAGS ALARM
```

Analog Input Calibrate Full-Scale

The Analog Input Calibrate Full-Scale screen allows the user to calibrate the full-scale state of the selected analog input.

- In the Main Menu, choose Service > Analog Input Cal > select Channel > **Calibrate Full Scale**. (Hook up a voltage source of 10 V to the analog input channel.)

```
ANALOG INPUT CAL:      SPAN
PROVIDE VOLTAGE TO INPUT!
 SELECTED INPUT:   INPUT 1
 CURRENTLY:         9.84 V
    SET TO:        10.00 V
     ↵ CALIBRATE TO VALUE

 RANGE  AVG  DIAGS ALARM
```

Language

The Language menu allows the user to choose languages include Chinese and English.

- In the Main Menu, choose **Service>Language**.

```
CHOOSE LANGUAGE:
 CURRENTLY:       ENGLISH
    SET TO:       CHINESE

              ↑↓ CHANGE VALUE
               ↵ SAVE

 RANGE   AVG   DIAGS ALARM
```

Display Pixel Test

The Display Pixel Test screen is used to test the LCD display, by toggling between all pixels on and all pixels off to ensure that they are functioning properly. The display pixel test screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

- In the Main Menu, choose Service > **Display Pixel Test**.

```
DISPLAY PIXEL TEST:
DURING TEST PRESS   OR →
TO EXIT, ↵ TO TOGGLE

      ↵ BEGIN TEST
        GO BACK TO MENU

 RANGE   AVG   DIAGS ALARM
```

Restore User Defaults

The Restore User Defaults screen is used to reset the user calibration and configuration values to factory defaults. The restore user defaults screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

- In the Main Menu, choose Service > **Restore User Defaults**.

```
RESTORE USER DEFAULTS:
                ↵ RESTORE



 RANGE   AVG   DIAGS ALARM
```

```
RESTORE USER DEFAULTS:
                ↵ RESTORE
ARE YOU SURE YOU WANT TO?
PRESS → TO CONFIRM RESTORE

 RANGE   AVG   DIAGS ALARM
```

Restore Factory Defaults

The Restore User Defaults screen is used to reset the user calibration and configuration values to factory defaults. The restore user defaults screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in this chapter.

- In the Main Menu, choose Service > **Restore User Defaults**.

```
RESTORE FACTORY DEFAULTS:

                 ↵ RESTORE



 RANGE  AVG  DIAGS ALARM
```

```
RESTORE FACTORY DEFAULTS:

                 ↵ RESTORE
ARE YOU SURE YOU WANT TO?
PRESS ➡ TO CONFIRM RESTORE

 RANGE  AVG  DIAGS ALARM
```

Password Menu

The Password menu allows the user to configure password protection. If the instrument is "locked", none of the settings may be changed via the front panel user interface, but they can still be changed via remote operation. When the front panel is locked, the user can still navigate the menu and view data, instrument parameters, and settings, but nothing can be changed. The password (lock) icon on the right side of the status bar indicates that the password lock is active. The items visible under the Password menu are determined by the instrument's password status.

- In the Main Menu, choose **Password**.

```
PASSWORD MENU:
>SET PASSWORD
 LOCK INSTRUMENT
 CHANGE PASSWORD
 REMOVE PASSWORD
 UNLOCK INSTRUMENT

 RANGE  AVG  DIAGS ALARM
```

Set Password

The Set Password screen is used to set the password that is used to unlock the front panel, and is shown if the instrument is unlocked and the password is not set.

- In the Main Menu, choose Password > **Set Password**

```
ENTER NEW PASSWORD:


     ABCDEFGHIJKLMN  BKSP
     OPQRSTUVWXYZ    PAGE
     0123456789 ./-  SAVE

 RANGE  AVG  DIAGS ALARM
```

Lock Instrument

The Lock Instrument screen is used to lock the instrument's front panel so users cannot change any settings from the front panel. The lock instrument screen is shown if the instrument is unlocked and the password is set.

- In the Main Menu, choose Password > **Lock Instrument**

```
LOCK FRONT PANEL:
   PRESSING ENTER WILL
PREVENT USER FROM CHANGING
 CONFIG FROM FRONT PANEL
 ↵ LOCK AND RETURN TO RUN

 RANGE  AVG  DIAGS ALARM
```

Lock/Unlock and Local/Remote Operation

If the instrument is locked via the front panel using Password > Lock Instrument, the instrument reports being in Remote mode. In this mode, the front panel is "locked", where data can be viewed, settings can be viewed but not changed using the front panel interface, and the remote "Set" commands are active.

If the instrument keyboard is unlocked via the front panel using Password > Unlock Instrument, the instrument reports being in Local mode, the front panel interface is unlocked, and settings can be changed from the front panel.

Refer to "C-Link Protocol Commands" appendix for detailed information about "mode", "allow mode", and "power up mode" commands.

Change Password

The Change Password screen is used to change the password used to unlock the instrument's front panel. The change password screen is shown if the instrument is unlocked.

- In the Main Menu, choose Password > **Change Password**

```
ENTER NEW PASSWORD:


 ABCDEFGHIJKLMN      BKSP
 OPQRSTUVWXYZ        PAGE
 0123456789 ./-      SAVE

 RANGE  AVG  DIAGS ALARM
```

Remove Password

The Remove Password screen is used to erase the current password and disable password protection. The remove password screen is shown if the instrument is unlocked and the password is set.

- In the Main Menu, choose Password > **Remove Password**

```
REMOVE PASSWORD:
   PRESSING ENTER WILL
 REMOVE CURRENT PASSWORD
   AND DISABLE LOCKING
     ↵ REMOVE PASSWORD

 RANGE  AVG  DIAGS ALARM
```

Unlock Instrument

The Unlock Instrument screen is used to enter the password to unlock the front panel. The unlock instrument screen is shown if the instrument is locked.

- In the Main Menu, choose Password > **Unlock Instrument**

Chapter 4
Calibration

The Model 5028*i* is an instrument that can make accurate mass concentration measurements of PM_{10}, $PM_{2.5}$ and $PM_{1.0}$. However, with all electronic instruments, the accuracy of the measurements depends on proper calibration.

In general terms, calibration, also called standardization, is the process that establishes the relationship between sensor output signals and the parameter the operator is attempting to measure. The 5028*i* instrument uses sensors that measure temperature, humidity, pressure, and radiation. This chapter describes the procedures for performing the necessary sensor calibrations. This chapter is also a follow-up to the Acceptance Testing outlined in the "Installation" chapter and a continuation of the menu display descriptions in the "Operation" chapter.

Frequency of Calibration

Each instrument is calibrated and tested for accuracy at the factory. The mass calibration is conducted with a set of NIST-traceable mass calibration foils. The radiation detector is calibrated against certified check sources for beta and alpha emissions. The temperature, relative humidity, pressure and flow rate are all calibrated against NIST traceable standards.

It is recommended that the instrument be calibrated once per year and encounter quality checks on a periodic basis in accordance with the users specific quality assurance project plan. For example, volumetric flow checks on a two-week basis are common in some air monitoring agencies and with full-scale quarterly audits for flow and mass. The *Quality Assurance Handbook for Air Pollution Measurement Systems*, published by the U.S. EPA, Research Triangle Park, NC 27711, can be consulted for detailed quality assurance guidelines.

Equipment Required

Optional mass transfer standards are available from Thermo Fisher Scientific for performing an annual mass calibration. However, additional specialized equipment is needed to calibrate the Model 5028*i* for temperature, relative humidity, barometric pressure, and volumetric flow. The following equipment should be used:

- A thermistor or thermocouple thermometer capable of measuring ambient temperatures in a range of –20 to 50 °C, readable to the nearest 0.1 °C. This thermometer should be referenced to within an accuracy of ±0.5 °C to NIST-traceable precision thermometers. Multiple thermometers may be used to cover the temperature range as long as each thermometer meets the accuracy and readability specifications described above.

- A barometer capable of measuring barometric pressure over a range of 600 to 800 mmHg (80 to 106 kilo Pascals [kPa]) and readable to the nearest 1 mmHg. At least once a year, this barometer should be calibrated to within ±5 mmHg of a NIST-traceable barometer of known accuracy.
- Flow-rate Transfer Standard (FTS) measurement equipment capable of calibrating, or verifying, the volumetric flow rate measurement with an accuracy of ±2 percent. This flow rate standard must be a separate, stand-alone device. It must have its own certification and be traceable to a NIST primary standard for volume or flow rate. Dry-piston meters and bubble flow meters should only be used under controlled laboratory conditions. Ambient field measurements should use a NIST-traceable low pressure drop orifice/venturi flow meter (such as, BGI Delta-Cal) or a Streamline Pro™ Model SX Kit (2-25 L/min).
- A relative humidity (RH) standard capable of measuring in the range of 35-75% RH, readable to the nearest 0.5% RH and accurate to within 2% RH.

Pre-Calibration

Prior to calibration, be sure the Model 5028*i* is operating properly. The Model 5028*i*'s internal diagnostics makes this a quick and simple process. Turn on the instrument and allow it to stabilize for one hour prior to calibrating. If you are receiving this instrument for the first time, the optional acceptance testing in the "Installation" chapter should also be reviewed. If the internal flow temperature sensor requires calibration, the dynamic heating system should be turned OFF, the cover should be removed, and the instrument should sample room temperature air at least one hour prior to calibrating.

Calibration Procedure

The order of calibration described below is preferred for optimal performance of the 5028*i* and comes from many years of experience working with and developing ambient particulate monitoring instrumentation. The Calibration submenus allow the user to view and calibrate the instrument. All calibration submenus are visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in Chapter 3.

RH/Temperature Calibration

All screens that appear in this chapter have been referenced in the previous chapter.

Ambient Temperature

Using a NIST-traceable thermometer as a reference collocated next to the ambient RH/temperature sensor assembly, measure and compare three individual readings between both the reference and the 5028*i* response. Taking an average of both sets of readings, calculate the average difference between the two readings and record that as your offset. This OFFSET should now be entered in the screen below:

```
CALIBRATE AMBIENT TEMP:
 TEMPERATURE:      29.9 °C
        ZERO:       4.2 °C

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. If it appears that the temperature has shifted into the wrong direction, change the sign of your offset value.

Ambient Relative Humidity

Using a NIST-traceable hygrometer as a reference collocated next to the ambient RH/temperature sensor assembly, measure and compare three individual readings between both the reference and the 5028*i* response. Taking an average of both sets of readings, calculate the average difference between the two readings and record that as your offset. This OFFSET should now be entered in the screen below:

```
CALIBRATE AMBIENT RH:
 REL HUMIDITY:      40.0 %
         ZERO:       0.0 %

           ↑↓ INC/DEC
            ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. If it appears that the temperature has shifted into the wrong direction, change the sign of your offset value.

Flow/Flow B Temperature

Assuming the instrument cover has been removed, the heater has been turned off and removed from the instrument and the instrument has been sampling room temperature air for 1-hour, this calibration can now proceed.

Using a NIST-traceable thermometer as a reference collocated next to the small sample tube inlet on top of the instrument, measure and compare three individual readings between both the reference and the 5028*i* response. Taking an average of both sets of readings, calculate the average difference between the two readings and record that as your offset. This OFFSET should now be entered in the screen below:

- In the Main Menu, choose Service > RH/Temp Calibration > **Flow Temp/ Flow Temp B**. Flow B Temperature settings please refer to Flow Temperature as following description.

```
CALIBRATE FLOW TEMP:
 TEMPERATURE:      28.0 °C
        ZERO:       0.8 °C

          ↑↓ INC/DEC
           ↵ SAVE VALUE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. If it appears that the temperature has shifted into the wrong direction, change the sign of your offset value.

Pressure/Vacuum Calibration

There are five pressure sensors that can be calibrated, however, the primary sensor to be calibrated is the barometric pressure sensor. Both the two vacuum sensors and two pressure flow sensors are re-zeroed automatically with every filter tape change.

Barometer Pressure Calibration

Using a NIST-traceable barometer, measure the barometric pressure (and convert as necessary) in units of millimetres of mercury (mmHg). Use the SPAN feature from the barometric calibration submenu.

```
BARO PRES CALIBRATION:
>SPAN                1.0000
 SET DEFAULTS



 RANGE  AVG  DIAGS ALARM
```

```
CAL BARO PRESSURE SPAN:
 PRESSURE:        760 mmHg
   SET TO:        747 mmHg?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. Repeat as necessary to within 2 mmHg.

Calibrate Vacuum/Flow Offset

The Calibrate Vacuum/Flow Offset screen calibrates the vacuum/flow sensor at zero value. This is done automatically with every filter tape change. However, if for any reason this needs to be done, proceed to the following screen below to execute a zeroing filter tape change.

In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Vac/Flow Offset**. Vac/Flow B settings please refer to Vac/Flow as following description.

```
CAL VACUUM/FLOW ZERO:
 VAC  ZERO:          0.0
 FLOW ZERO:          0.0

 ↵ TO CALIBRATE ZERO BY
      CHANGING FILTER

 RANGE  AVG  DIAGS ALARM
```

Calibrate Vacuum Pressure Span

The Calibrate Vacuum Pressure Span screen allows the user to view and set the vacuum sensor calibration span point.

To calibrate the vacuum sensor, zero a digital manometer (capable of measuring up to 100 mmHg) to the +ΔP port on the rear panel. Then push the toggle switch on the right inward to open (see Figure 4–1). The manometer reading can now be used to calibrate the vacuum sensor. +ΔPA port uses for Channel A, and +ΔPB port uses for Channel B.

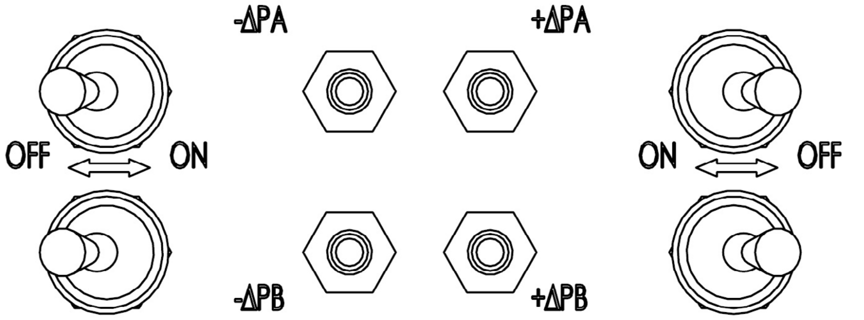


Figure 4–1. Differential Pressure and Vacuum Calibration Ports

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B > **Vac Pres Span**. Vac/Flow B settings please refer to Vac/Flow as following description.

```
CAL VAC PRESSURE SPAN:
 VACUUM:          58.7 mmHg
 SET TO:          60.0 mmHg?

          ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE    ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Calibrate Flow Pressure Span

The Flow Pressure Span screen allows the user to view and set the flow sensor calibration span point.

To calibrate the flow pressure sensor span point, the instrument must be pulling an active flow through the filter tape. By use of a manometer, connect the respective +/- ports of your NIST-traceable manometer to the respective rear panel +/- ports. (Please be certain to zero any digital manometers prior to connecting!) Open the ports by pressing the toggle switches inward. Calculate an average reading from the reference manometer in units of mmHg. +/- ΔPA ports use for Channel A, and

+/- ΔPB ports use for Channel B. Enter this span value into the screen below:

- In the Main Menu, choose Service > Pres/Vacuum Calibration > Vac/Flow or Vac/Flow B> **Flow Pres Span**. Vac/Flow B settings please refer to Vac/Flow as following description.

```
CAL FLOW PRESSURE SPAN:
 FLOW:          21.0 mmHg
 SET TO:        20.0 mmHg?

         ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. Repeat as necessary to within 2 mmHg.

Flow Calibration

The preferred method of flow rate calibration is the Auto Flow Calibration.

Auto Flow Calibration

Place a NIST-traceable volumetric flow meter on top of the instrument after complete installation (reassembled heater tube, sample tubes, and inlets). Allow approximately 1-minute for the flow to stabilize. Once stable, measure and average three individual readings from the reference. This average observed flow rate from your reference meter should now be entered in the screen below:

```
FLOW AUTO CALIBRATION:
   FLOW:        16.67 LPM
 SET TO:        17.28 LPM?

         ←→ MOVE CURSOR
 ↑↓ CHANGE VALUE   ↵ SAVE

 RANGE  AVG  DIAGS ALARM
```

Be sure to save the entry and compare the values once more. Repeat as necessary to within +/- 2 %. Flow Span B settings please refer to Flow Span as above description.

Perform the “Leak Test” on page 5-6 to verify no leaks.

Mass Calibration

The Model 5028*i* is calibrated for mass in the factory using a series of null and span foils. The mass transfer standard foil sets are available from Thermo Fisher Scientific, and should be used as part of a QA Program for performing a QC check on the mass measurements. This mass foil calibration procedure can be used for QC checks, auditing, and calibration.

The Mass Calibration submenu is used to view and set the mass calibration point. The mass calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in the chapter.

Note This adjustment should only be performed by an instrument service technician. ▲

- In the Main Menu, choose Service > **Mass Calibration>Mass Coefficient or Mass Calibration B**. Mass Calibration B settings please refer to Mass Calibration as following description.

```
MASS CALIBRATION:
 THERMAL    COEFFICIENT
 VACUUM     COEFFICIENT
 BARO       COEFFICIENT
>MASS       COEFFICIENT
 ALPHA EFF  COEFFICIENT

 RANGE   AVG   DIAGS  ALARM
```

It is recommended to perform an annual mass calibration on the Model 5028*i* Monitor.

- The foil sets must be kept in a clean container. **Do not** touch the foil window with your fingers.
- The foils must **not** be wiped, otherwise a loss or gain of mass can occur thereby biasing the mass calibration.
- Foils sets can be returned to Thermo Fisher Scientific for recalibration as necessary.
- Separate foil sets are recommended for periodic QC checks, auditing, and calibration.
- Should the user suspect the foil window(s) has been damaged, scratched, or coated, these foil sets should be returned to Thermo Fisher Scientific for re-calibration.

The null foil has the same approximate mass as a clean filter spot and the span foil is a calibrated mass increase above the null foil. Therefore, the foils come in a set and must not be mixed with other sets since a bias in mass calibration will occur.

Since the beta attenuation method is linear with mass increase, the Model 5028*i* need not be calibrated in the exact range of beta attenuation per filter spot. What is important, is calibrating the corresponding beta count reduction with an increase of calibrated mass.

Note To achieve the most accurate mass calibration, the flow temperature should be as stable as possible and therefore the instrument should have the heating system turned off, and the instrument should be allowed to equilibrate to shelter or ambient temperature. If the Model 5028*i* is mounted within an ambient shelter, then the most stable time of day to perform a mass calibration would be either early morning or late afternoon. ▲

Mass Coefficient

The preferred method of mass coefficient calibration is the Auto Mode.

- In the Main Menu, choose Service > Mass Calibration or Mass Calibration B > **Mass Coefficient**.

```
MASS COEFFICIENT:
>AUTO
 MANUAL



 RANGE   AVG   DIAGS ALARM
```

Auto Mass Coefficient

The Auto Mass Coefficient screen allows the user to conduct a mass calibration of the measurement head and will walk you through the process.

Use the following procedure to conduct a mass calibration:

1. In the Main Menu, choose Service > Mass Calibration > **Mass Calibration or Mass Calibration B>** Mass > **Auto**.
2. Enter the SPAN foil value (e.g., 1,328 µg) using the keypad and press ↵ to save the foil value and to open the bench. The beta attenuation chamber should now open.

```
MASS COEF:        7000.0
FOIL VALUE:       1328  µg


   ↵ TO SAVE FOIL VALUE
   AND OPEN BENCH
 RANGE   AVG   DIAGS ALARM
```

3. Cut/break the filter tape and remove from the bench. Then insert the Foil Holder from the calibration kit and press ↵ while maintaining a slight sideward pressure on the filter holder.

```
MASS COEF:        7000.0
FOIL VALUE:       1328  µg


 REMOVE TAPE, INSERT FOIL
 HOLDER, ↵ TO CLOSE BENCH
 RANGE   AVG   DIAGS ALARM
```

4. Insert the Null/Zero foil with the label side up and press ↵ to proceed with the foil calibration, or press ■ to stop the foil.

```
MASS COEF:      7000.0
FOIL VALUE:     1328 µg


   INSERT NULL FOIL
   ↵ TO START ZERO CAL

 RANGE  AVG  DIAGS ALARM
```

```
MASS COEF:      7000.0
FOIL VALUE:     1328 µg
Beta Avg        12016 1/sec


   PLEASE WAIT     265 sec

 RANGE  AVG  DIAGS ALARM
```

The auto zero procedure of mass will begin and last approximately 270 seconds. When the zero is complete, the beta attenuation measurement will remain closed and an average Beta count rate is displayed.

```
MASS COEF:      7000.0
FOIL VALUE:     1328 µg
Beta Avg       12022 1/sec

   REMOVE NULL FOIL
   ↵ TO CONTINUE

 RANGE  AVG  DIAGS ALARM
```

5. Remove the zero/null foil and insert with the Span foil (e.g., 1328 ug) and press ↵ to begin the span calibration, or press ■ to stop the foil.

```
MASS COEF:      7000.0
FOIL VALUE:     1328 µg
Beta Avg       12022 1/sec

   INSERT SPAN FOIL
   ↵ TO START MASS CAL

 RANGE  AVG  DIAGS ALARM
```

```
MASS COEF:      7000.0
FOIL VALUE:     1328 µg
Beta Avg        9884 1/sec


   PLEASE WAIT    245 sec

 RANGE  AVG  DIAGS ALARM
```

The span foil calibration procedure is now active and after another 270 seconds the calibration procedure should end, whereby a new Mass Coef value is shown and the percent difference is shown from the last foil calibration to the current calibration. This percent difference can also be used to directly audit the mass coefficient value since a percent difference in a mass coefficient is the same percent mass difference overall.

```
MASS COEF:       6878.7
FOIL VALUE:     1328 µg
Beta Avg        9911 1/SEC
difference      -1.7 %
   REMOVE SPAN FOIL
   ↵ TO CONTINUE

 RANGE  AVG  DIAGS ALARM
```

6. After the span calibration, the screen will ask you to press ↵ to accept the new calibration. Otherwise press ■ to keep the old Mass Coef value. Remove the span foil and press ↵. The bench will now open. Remove the filter holder, replace the filter tape

and press ↵ to confirm the calibration routine has now been competed.

```
MASS COEF:        6878.7
FOIL VALUE:       1328  µg
Beta Avg          9911  1/sec
difference        -1.7 %
  REMOVE HOLDE, INSERT
 TAPE, ← TO CLOSE BENCH

 RANGE  AVG  DIAGS ALARM
```

```
MASS COEF:        6878.7
FOIL VALUE:      1328  µg
Beta Avg         9911  1/sec
difference       -1.7 %
   ↵ TO ACCEPT NEW VALUES
   ← TO DECLINE

 RANGE  AVG  DIAGS ALARM
```

Detector Calibration

The Detector Calibration submenu is used to view and set the detector calibration. The detector calibration screen is visible only when the instrument is in service mode. For more information on the service mode, see "Service Mode" earlier in the chapter.

Note This adjustment should only be performed by an instrument service technician. Detector Calibration B settings please refer to Detector Calibration as following description. ▲

- In the Main Menu, choose Service > **Detector Calibration or Detector Calibration B**.

```
DETECTOR CALIBRATION:
>AUTO
 MANUAL




 RANGE  AVG  DIAGS ALARM
```

Auto Detector Calibration

The Auto Detector Calibration screen allows the user to optimize the detector performance. This should be done at least once per year and as often as once per quarter.

- In the Main Menu, choose Service > Detector Calibration > **Detector Calibration or Detector Calibration B** > **Auto**.

```
DETECTOR AUTO CAL:
 HIGH VOLT:    1500 V
 BETA CNT :   14649 1/sec

PRESS ↵ TO START AUTO CAL

 RANGE  AVG  DIAGS ALARM
```

This procedure will take approximately 30 minutes until completed. Thereafter, a high voltage (HV), beta reference threshold and alpha threshold will be assigned a new valve. **Detector Calibration B** please refer to Detector Calibration as above description, another approximately 30 minutes is needed until completed.

Chapter 5
Preventive Maintenance

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper operation. Since usage and environmental conditions vary greatly, you should inspect the components frequently until an appropriate maintenance schedule is determined.

This chapter includes the following preventive maintenance information:

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.

WARNING If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

Replacement Parts

See the "Servicing" chapter for a list of replacement parts and the associated replacement procedures.

WARNING If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

Cleaning the Outside Case

Clean the outside case using a damp cloth being careful not to damage the labels on the case.

Equipment Damage Do not use solvents or other cleaning products to clean the outside case. ▲

Cleaning the Inlets

The inlet assemblies can include a TSP inlet, a U.S. EPA compatible PM_{10} inlet, or a Digital PM_{10} or $PM_{2.5}$ inlet. Cleaning schedules and routine maintenance of assembly components should be in accordance with a good quality assurance plan.

In general, it is recommended that the inlet assemblies be cleaned on a quarterly interval with mild soap solution, a thorough rinsing, and dried with a lint free cloth. If any impaction surfaces require impactor grease, it should be applied prior to reassembly. Furthermore, a general inspection, and replacement as necessary, of o-rings should be done.

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

U.S. EPA PM_{10} Inlet

The water collector bottle located on the PM_{10} inlet should be inspected at least every five sampling days (Figure 5–1). Remove any accumulated water, clean the interior of the bottle, inspect the seals, and replace the bottle in the holder.

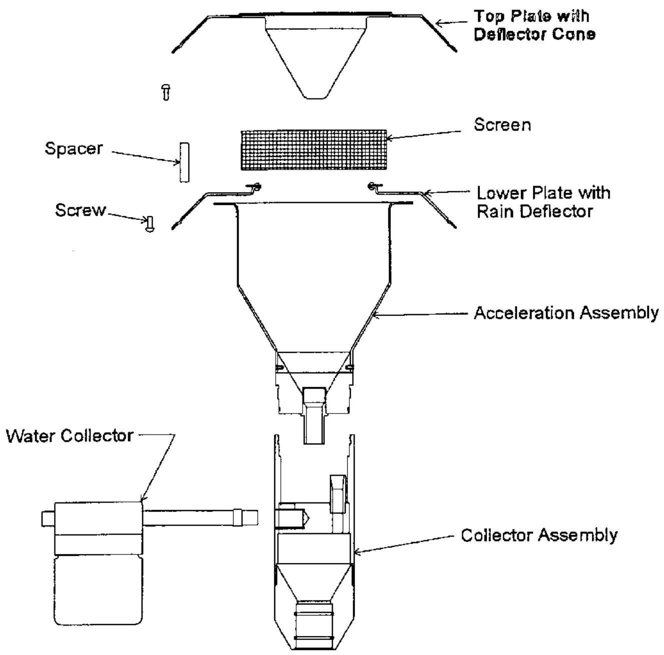


Figure 5–1. U.S. EPA PM_{10} Inlet

Once a month the sampler inlet should be dismantled and cleaned. Mark each assembly point of the sampler inlet with a pen or pencil to provide reference marks during reassembly.

Disassemble the sample inlet unit according to Figure 5–1. If the assembly screws are frozen, apply penetrating oil or commercial lubricant to make removal easier. Clean all interior surfaces and the bug screen with a general purpose cleaner or compressed air, paying particular attention to small openings and cracks. Cotton swabs and/or a small brush are helpful. Completely dry all components.

Also monthly, check the O-rings for distortion, cracks, fraying, or other problems and replace as necessary. Apply small amounts of grease to the rings before assembling the unit.

Reassemble the unit in accordance with the previously scribed match marks. Particular care should be taken to ensure that all O-rings seals are properly seated and that all screws are uniformly tightened.

European PM_{10}/$PM_{2.5}$ Inlet

The same schedule should be used for the European PM_{10} Inlet (e.g. Leckel), at approximately a 1-2 month interval. The components of the inlet should be inspected and cleaned as necessary. Figure 5–2 provided below provides an image and design drawing of the inlet, with references to parts.

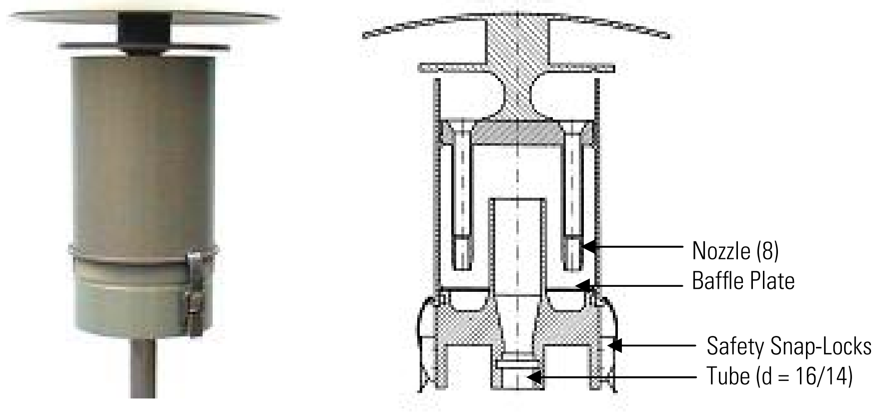


Figure 5–2. European PM_{10} Inlet

PM_{10} size selective inlet (1 m^3/h) for 5028*i* :

- Same construction as the EN reference inlet, but with 1 m^3/h
- With special surface protection using an aluminium EMATAL surface
- With special water separator and easy exchangeable impactor baffle plate
- Standard tube connection: d = 16 mm for connecting a continuous monitor
- Easy converting to $PM_{2.5}$ using the $PM_{2.5}$ nozzle plate (8 nozzles)
- Easy converting to PM_1 using the PM_1 nozzle plate (8 nozzles)

Cyclone Maintenance

If a Sharp-Cut Cyclone (SCC) or a BGI Very Sharp-Cut Cyclone is being used for $PM_{2.5}$ sampling (Figure 5–3), once every 2-3 weeks the dust pot should be unscrewed, emptied, and cleaned with a lint-free cloth. Once every three months, the entire SCC assembly should be inspected and cleaned, O-rings checked for distortion, cracks, fraying, or other problems. Replace O-rings as necessary.

Figure 5–3. $PM_{2.5}$ Sharp-Cut-Cyclone

Heater and Sample Tube

On at least an annual basis (more frequently in heavily polluted environments) the sample tube that attaches to the inlet and to the Model 5028*i* should be removed and cleaned. The use of a bottle brush and string will allow you to remove any deposits within the sample tube. This same procedure also applies to the heater tube.

Weather Proofing

The "Installation" chapter covers detailed installation instructions. After proper installation, it is recommended to check the weather-proof installation at all interfaces exposed to ambient conditions. Ensure that the condition of the roof flange and silicone caulking will prevent any precipitation from entering the shelter and possibly damaging the instrument's electronics.

Fan Filter Inspection and Cleaning

Use the following procedure to inspect and clean the fan filter (Figure 5–4).

1. Remove the fan guard from the fan and remove the filter.
2. Flush the filter with warm water and let dry (a clean, oil-free purge will help the drying process) or blow the filter clean with compressed air.
3. Re-install the filter and fan guard.

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

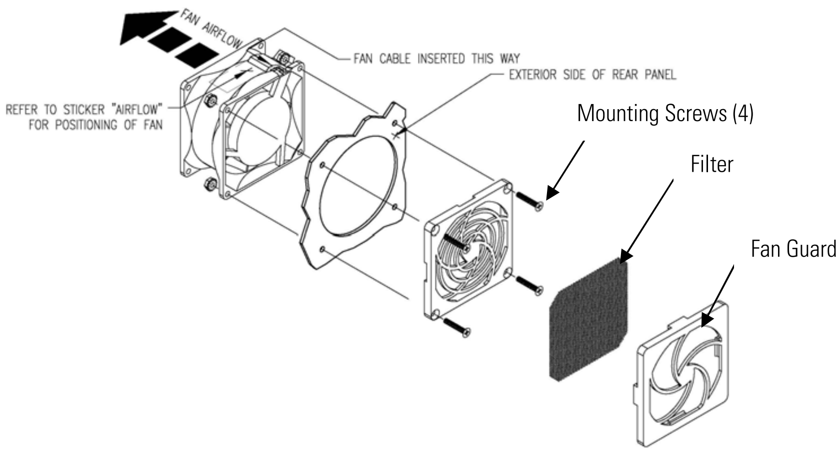


Figure 5–4. Inspecting and Cleaning the Fan

Pump Rebuilding

Rebuild the sample pump once every 12–18 months, or as necessary depending on the environment is is used in. The pump repair kit contains instructions for rebuilding the pump. See the "Servicing" chapter for a list of replacement parts. Perform the "Leak Test" procedure that follows.

Leak Test

This leak test procedure uses a volumetric flow meter and a custom leak check adapter. Use the following procedure to verify no leaks.

1. Place a reference volumetric flow meter (e.g., BGI Delta Cal) onto the inlet adapter and calibrate the 5028*i* so that the reference flow meter and the 5028*i* monitor read the same flow rate.
2. Install the custom leak check adapter onto the inlet adapter and then place the reference flow meter onto the leak check adapter.
3. Record the reference volumetric flow meter reading and the instant flow reading. If the difference between both readings is less than 0.42 L/min (±2.5%), the leak check passes.

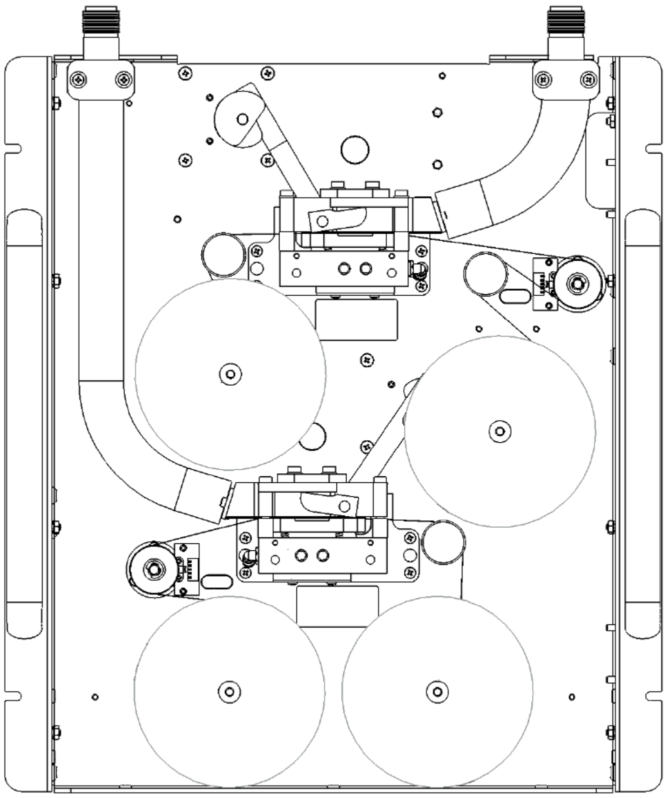
Filter Tape Replacement

Use the following procedure to replace the filter tape in case of breaks or if the tape runs out.

⚠ **Equipment Damage** Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. For more information about appropriate safety precautions, see the "Servicing" chapter. ▲

1. Open the front door.
2. From the main menu choose Instrument Controls > Filter Tape Control > Manual > **Bench(s)**. Press ↵.

3. Loosen both reel nuts on tape spindles. Remove used filter tape and empty tape spool from tape spindles.
4. Insert new filter tape on left tape spindle and tighten reel nut for Channel A(Upper). Insert new filter tape on the right tape spindle and tighten reel nut for Channel B(Under).
5. Insert new blank pick up spool on right tape spindle for Channel A(Upper), and insert new blank pick up spool on left tape spindle for Channel B(Under).
6. Route tape according to Figure 5–5.
7. Attach end of tape to blank tape spool on right tape spindle with 2-inch of tape for Channel A(Upper), and attach end of tape to blank tape spool on left tape spindle with 2-inch of tape for Channel B(Under).
8. Turn blank tape spool until there is two complete wrappings of tape.
9. Tighten right reel nut for Channel A(Upper), and tighten left reel nut for Channel B(Under). From Filter Tape Control > Manual > choose **Tape** and press ↵ to MOVE tape.
10. From the main menu choose Alarms > **Instrument Alarms** to verify that there are no filter tape alarms.
11. Confirm the filter tape can move correctly, then close front door.



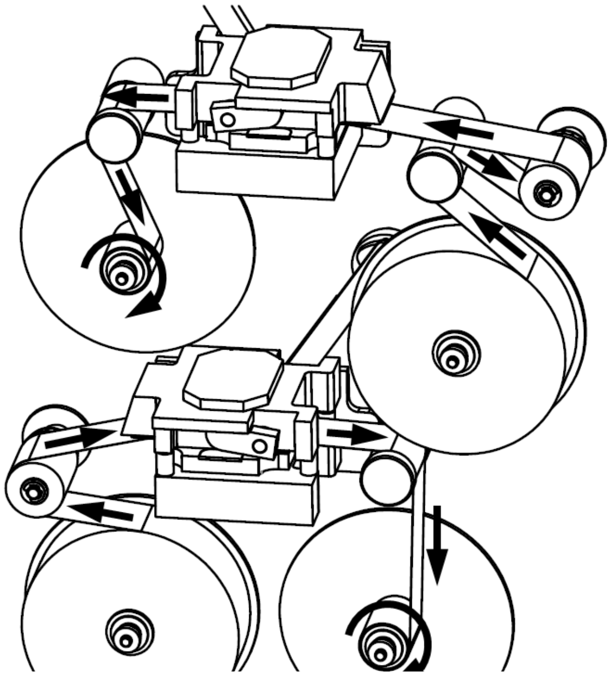


Figure 5–5. Replacing the Filter Tape

Greasing the Cam

Use the following procedure to grease the cam.

Equipment Required:

Dow Corning Molykote G-N

1. Apply metal assembly paste around the parameter of the cam.

Chapter 6
Troubleshooting

This instrument has been designed to achieve a high level of reliability. In the event of problems or failure, the troubleshooting guidelines, board-level connection diagrams, connector pin descriptions, and testing procedures presented in this chapter should be helpful in isolating and identifying problems.

The Technical Support Department at Thermo Fisher Scientific can also be consulted in the event of problems. See "Service Locations" on page 6-22 for contact information. In any correspondence with the factory, please note both the serial number and program number of the instrument.

This chapter provides the following troubleshooting and service support information:

Safety Precautions

Read the safety precautions in the Preface and "Servicing" chapter before performing any actions listed in this chapter.

Troubleshooting Guides

The troubleshooting guides presented in this chapter are designed to help isolate and identify instrument problems.

Table 6–1 provides general troubleshooting information and indicates the checks that you should perform if you experience an instrument problem.

Table 6–2 lists all the alarm messages you may see on the graphics display and provides recommendations about how to resolve the alarm condition.

Table 6–1. Troubleshooting - General Guide

Malfunction	Possible Cause	Action
No power	Main fuses are blown are missing	Check voltages from power supply.
	Digital electronics defective	Check that all boards and connectors are seated properly.
		Replace with spare boards to isolate the problem.
No automatic filter change	Reel nuts not tight	Tighten reel nuts.
	No more filter tape	Replace with new filter tape.
	Filter not properly adhered or broken	Adhere filter tape to take-up reel and wind over itself once.
	Filter tape transport drive motor defective	Replace motor.
	Optical tape counter defective	Replace optical tape transport sensor.
Pressure sensor(s) board do not hold calibration	Valves closed	Verify ΔP valves on rear panel are in the closed position.
	Loose plumbing	Verify all plumbing connections.
	Pressure board defective	Replace pressure printed circuit board.
Highly variable concentration	Recorder noise	Replace or repair recorder and/or leads.
	Sample concentration varying	Run Model 5028*i* on a zero filter – if quiet, there is no malfunction.
	Foreign material in optical bench	Clean optical bench.
	Digital electronics defective	Replace board with a spare board.
Instrument does not calibrate properly	System leak	Find and repair leak.
	Pressure or temperture out of calibration	Re-calibrate pressure or temperature.
	Digital electronics defective	Replace one board at a time with a spare board to isolate the defective board.
	Flow	Verify ΔP valves on rear panel are in the closed position.
		Re-calibrate.
Display is off	Wrong contrast setting	Adjust contrast setting.
	LCD cable loose	Check connection and cable integrity.
	LCD defective	Replace display.

Malfunction	Possible Cause	Action
The change of parameters is not possible	Keyboard not enabled	Enable keyboard through menu.
No mass value	ADC defect	Change the main circuit board.
	Mains are broken	Check and repair.
	No high voltage value	Check HV.
	Detector defect	Change detector.
No automatic filter change	Mechanical defect	Check filter transport motor and mechanics. Make sure tape is adhered to take-up reel and intact.
	If pump is not running	Check pump power supply and wires.
	If the filter change parameter reaches the FC-value for the second time, then, the monitor stops	Adjust filter change parameters.
	If three way valve power off	Check valve power supply and wires
LCD out of function or dark	Wrong contrast	Adjust contrast.
	LCD defect	Change LCD.
	Connection cables from the main board are broken	Replace display ribbon cable.
Air flow rate disturbance or air flow is too low	Air flow parameters wrong	Check air flow rate parameters.
	No connection with plug (25) "pump"	Put in the plug (pump regulation input).
	Pump do not work properly	Clean inside parts of pump change.
	Three way valve do not work properly	Change three way valve
	Very high pollution or blocking in the air passage	Clean air passage.
	Check ΔP calibration valve are in closed position	Close valves.

Table 6–2. Troubleshooting - Alarm Messages

Alarm Message	Possible Cause	Action
Instrument Alarms – Filter Tape Counter	Loose reel nuts	Tighten reel nuts.
	Broken tape	Replace tape.
	Loose photo interrupt cable	Verify connections.
Instrument Alarms – Filter Tape Change	Loose reel nuts	Tighten reel nuts.
	Broken tape	Replace tape.
	Tape motor nut turning	Verify connection to measurement interface board.
		Replace tape motor.
Instrument Alarms – Bench	Cam working not functioning	Verify connector to measurement interface board.
		Replace motor.
	Motor turning, cam not	Verify setscrews on cam coupling.
Instrument Alarms-Heater Power	Loose heater power cable	Verify connections.
	Measurement interface board dose not work properly	Replace the measurement interface board.
Instrument Alarms – Motherboard Status	Internal cables not connected properly	Check that all internal cables are connected properly. Re-cycle AC power to instrument. If still alarming, change board.
Instrument Alarms – Interface Status	Board defective	Replace board.
Instrument Alarms – I/O Exp Status	Board defective	Replace board.
Detector Alarms –Board Status	Board defective	Replace board.
Detector Alarms – Alpha	Detector	Re-calibrate detector.
	Settings	Verify alarm settings are between 0 minimum and 100 maximum.
Detector Alarms – Beta	Disconnected cable	Verify cable connections.
	Defective detector	Replace detector-Beta counts trending towards zero.
	Settings	Verify alarm settings are between 5000 minimum and 20000 maximum.

Alarm Message	Possible Cause	Action
RH/Temperature Alarms – Ambient RH	Disconnect cable (external) on rear panel	Verify cable connection.
	Disconnect cable (internal)	Verify cable connection.
RH/Temperature Alarms – Sample RH	Disconnected heater	Verify cable connection.
RH/Temperature Alarms – Ambient Temp	Disconnect cable (external) on rear panel	Verify cable connection.
	Disconnect cable (internal)	Verify cable connection.
RH/Temperature Alarms – Flow Temp	Disconnected cable	Verify connection to measurement interface board.
	Sensor defective	Replace sensor.
RH/Temperature Alarms – Board Temp	Disconnected cable	Verify connection to measurement interface board.
	Sensor defective	Replace sensor.
Pressure/Vacuum Alarms – Barometer Pressure	Disconnected cable	Verify cable connections.
		Replace board.
Pressure/Vacuum Alarms – Vacuum	Disconnected plumbing	Verify plumbing connections.
	Disconnected cable	Verify cable connection.
	Sensor defective	Replace pressure board.
Pressure/Vacuum Alarms – Flow	Disconnected plumbing	Verify plumbing connections
	Disconnected cable	Verify cable connection.
	Sensor defective	Replace pressure board.
	ΔP valve open	Verify valve is in close position.
Flow Alarms – Flow	Low flow	Check that pump is connected.
		Verify that both ΔP valves are in the closed position.
	No flow	Verify proportional valve plumbing.
		Verify connection to measurement interface board.
Conc Alarms – Inst PM	Conc negative	Check heater and Beta counts.
	Conc alarm setting	Verify conc alarm settings.
Conc Alarms – Avg PM	Conc negative	Check heater and Beta counts.
	Conc alarm setting	Verify conc alarm settings.

Board-Level Connection Diagrams

Figure 6–1 and Figure 6–2 are board-level connection diagrams for the common electronics and measurement system. These illustrations can be used along with the connector pin descriptions in Table 6–3 through Table 6–7 to troubleshoot board-level faults.

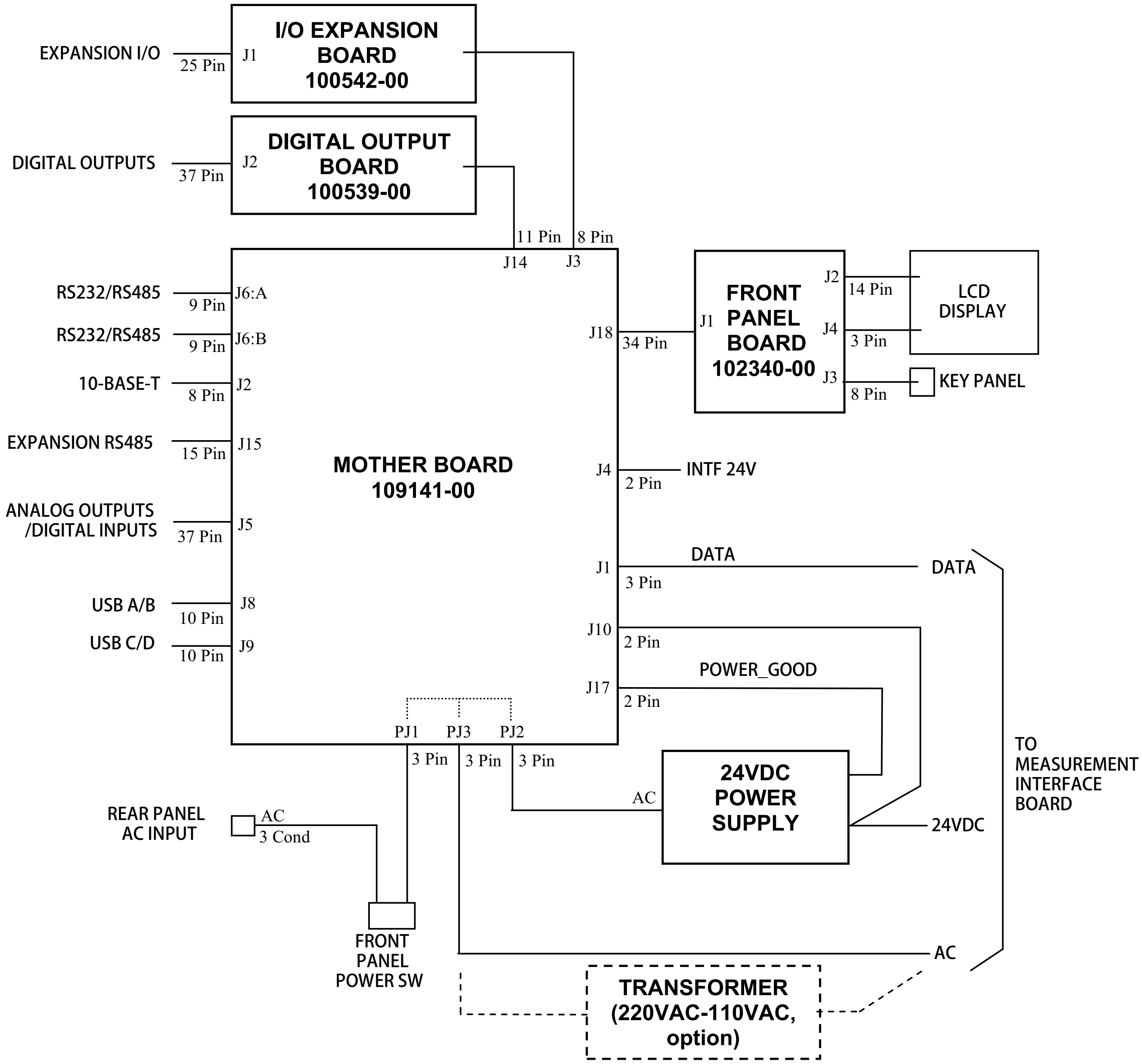


Figure 6–1. Board-Level Connection Diagram - Common Electronics

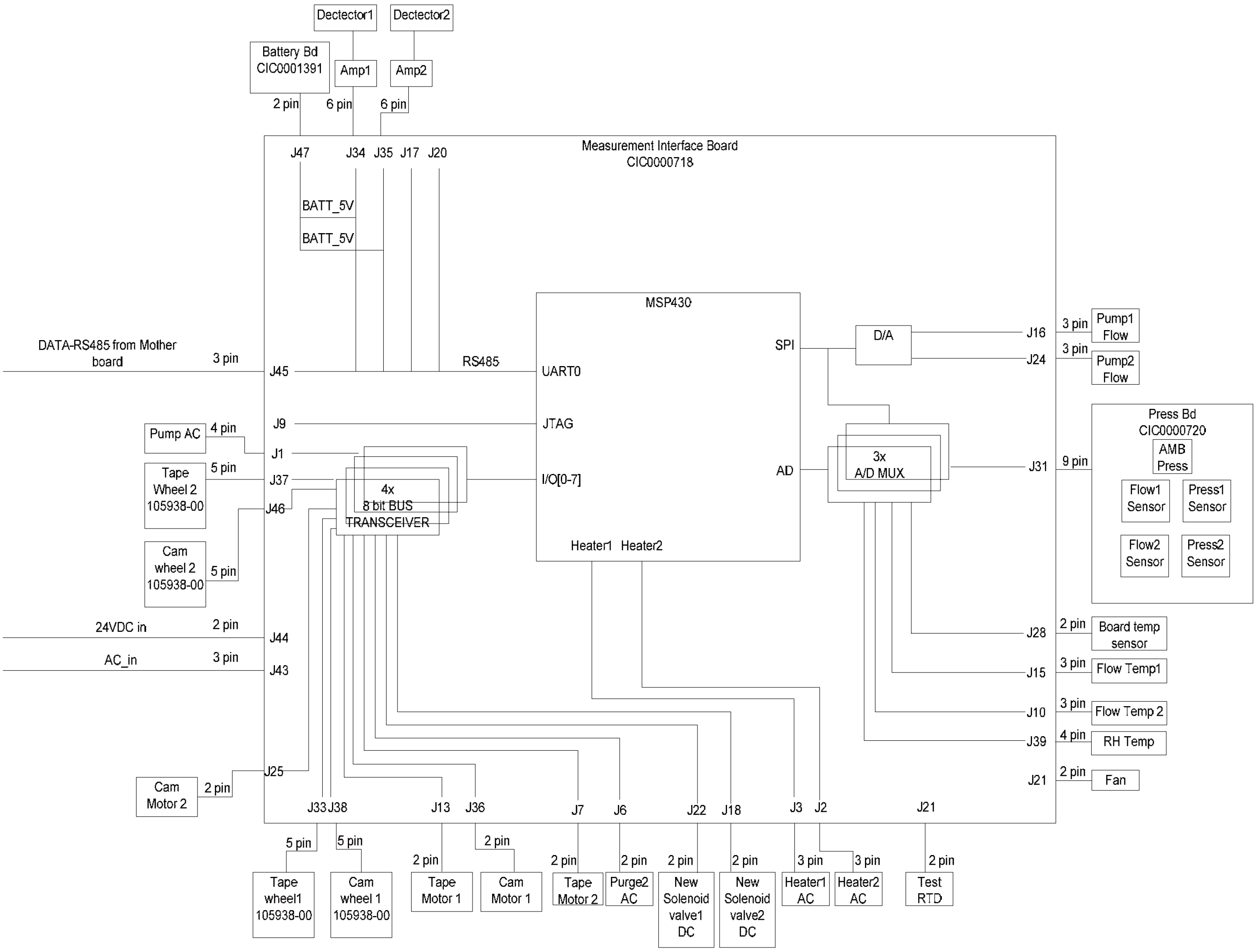


Figure 6–2. Board-Level Connection Diagram - Measurement System

Connector Pin Descriptions

The connector pin descriptions in Table 6–3 through Table 6–7 can be used along with the board-level connection diagrams to troubleshoot board-level faults.

"Motherboard Connector Pin Descriptions" on page 6-8

"Measurement Interface Board Connector Pin Descriptions" on page 6-13

"Front Panel Board Connector Pin Diagram" on page 6-17

"I/O Expansion Board (Optional) Connector Pin Descriptions" on page 6-19

"Digital Output Board Connector Pin Descriptions" on page 6-20

Table 6–3. Motherboard Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
INTF DATA	J1	1	Ground
		2	+RS485 to Interface Board
		3	-RS485 to Interface Board
10-BASE-T	J2	1	Ethernet Output (+)
		2	Ethernet Output (-)
		3	Ethernet Input (+)
		4	NC
		5	NC
		6	Ethernet Input (-)
		7	NC
		8	NC
EXPANSION BD	J3	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Expansion Board
		8	-RS485 to Expansion Board
INTERFACE 24V	J4	1	+24V
		2	Ground
I/O	J5	1	Power Fail Relay N.C. Contact
		2	Digital Ground
		3	TTL Input 1
		4	TTL Input 2
		5	Digital Ground
		6	TTL Input 5
		7	TTL Input 7
		8	TTL Input 8
		9	TTL Input 10
		10	Ground
		11	TTL Input 13
		12	TTL Input 15
		13	Digital Ground

Connector Label	Reference Designator	Pin	Signal Description
		14	Analog Voltage 1
		15	Analog Voltage 3
		16	Analog Ground
		17	Analog Voltage 5
		18	Analog Ground
		19	Analog Ground
		20	Power Fail Relay COM
		21	Power Fail Relay N.O. Contact
		22	Digital Ground
		23	TTL Input 3
		24	TTL Input 4
		25	TTL Input 6
		26	Digital Ground
		27	TTL Input 9
		28	TTL Input 11
		29	TTL Input 12
		30	TTL Input 14
		31	TTL Input 16
		32	Digital Ground
		33	Analog Voltage 2
		34	Analog Voltage 4
		35	Analog Ground
		36	Analog Voltage 6
		37	Analog Ground
VOLTAGE TEST	J6	1	+5V
		2	+3.3V
			+15V
			-15V
SER EN	J7	1	Serial Enable Jumper
		2	+3.3V
USB A/B	J8	1	VBUS_A
		2	VBUS_B
		3	USB_PORTA_N
		4	USB_PORTB_N
		5	USB_PORTA_P

Connector Label	**Reference Designator**	**Pin**	**Signal Description**
		6	USB_PORTB_P
		7	GND
		8	GND
		9	GND
		10	GND
USB C/D	J9	1	VBUS_C
		2	VBUS_D
		3	USB_PORTC_N
		4	USB_PORTD_N
		5	USB_PORTC_P
		6	USB_PORTD_P
		7	GND
		8	GND
		9	GND
		10	GND
24V IN	J10	1	+24V
		2	Ground
WDT DISABLE	J11	1	+3.3V
		2	GND
RESET PROC	J12	1	Reset-Proc
		2	Ground
DIGITAL I/O	J14	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
EXT. RS485	J15	1	-RS485 to Rear Panel
		2	-RS485 to Rear Panel
		3	+5V

Connector Label	Reference Designator	Pin	Signal Description
		4	+5V
		5	+5V
		6	Ground
		7	Ground
		8	Ground
		9	NC
		10	NC
		11	+24
		12	+24
		13	+24
		14	+24
		15	+24
24 MONITOR	J17	1	24V Power Monitor
		2	Ground
FRONT PANEL BD	J18	1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltagel
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input

Connector Label	Reference Designator	Pin	Signal Description
		22	Keypad Row 1 Input
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground
		32	Ground
		33	+24V
		34	+24V
RS232/RS485:A	J6:A	1	NC
		2	Serial Port 1 RX (-RS485 IN)
		3	Serial Port 1 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 1 RTS (+RS485 OUT)
		8	Serial Port 1 CTS (+RS485 IN)
		9	NC
RS232/RS485:B	J6:B	1	NC
		2	Serial Port 2 RX (-RS485 IN)
		3	Serial Port 2 TX (-RS485 OUT)
		4	NC
		5	Ground
		6	NC
		7	Serial Port 2 RTS (+RS485 OUT)
		8	Serial Port 2 CTS (+RS485 IN)
		9	NC
AC IN	PJ1	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground
AC 24VPWR	PJ2	1	AC-HOT

Connector Label	Reference Designator	Pin	Signal Description
		2	AC-NEUT
		3	AC-Ground
AC INTF BD	PJ3	1	AC-HOT
		2	AC-NEUT
		3	AC-Ground

Table 6–4. Measurement Interface Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
PUMP	J1	1	AC+
		2	Pump_AC-
		3	AC-Ground
		4	NC
HEATER 2	J2	1	AC+
		2	Heater2_AC-
		3	AC-Ground
HEATER 1	J3	1	AC+
		2	Heater1_AC-
		3	AC-Ground
WDT DISABLE	J4	1	Input
		2	Ground
AUX PWR 120V	J5	1	AC+
		2	AC-
PURGE 2	J6	1	AC+
		2	Purge2_AC-
PURGE 1	J7	1	AC+
		2	Purge1_AC-
PUMP 1	J8	1	+24V
		2	Pump1_On/Off
JTAG INTF	J9	1	TD0
		2	NC
		3	TD1
		4	NC
		5	TMS
		6	NC

Connector Label	Reference Designator	Pin	Signal Description
		7	TCK
		8	NC
		9	Ground
		10	NC
		11	NC
		12	NC
		13	NC
		14	NC
FLOW TEMP 2	J10	1	Flow2A_RTD
		2	Flow2B_RTD
		3	Ground
AUX HT 1	J11	1	AC+
		2	AuxHT_1_AC-
AUX HT 2	J12	1	AC+
		2	AuxHT_2_AC-
TT MOTOR	J13	1	AC+
		2	TT Motor_AC-
PUMP 2	J14	1	+24V
		2	Pump2_On/Off
FLOW TEMP 1	J15	1	Flow1A_RTD
		2	Flow1B_RTD
		3	Ground
SHARP 1	J17	1	+24V
		2	+RS485
		3	-RS485
		4	Ground
PURGE 2 DC	J18	1	+24V
		2	Purge2_DC
PUMP FLOW 1	J19	1	+24V
		2	Aout_Pump1_Flow
		3	Ground
SHARP 2	J20	1	+24V
		2	+RS485
		3	-RS485
		4	Ground

Connector Label	Reference Designator	Pin	Signal Description
FAN	J21	1	+24V
		2	Fan_Power
PURGE 1 DC	J22	1	+24V
		2	Purge1_DC
PUMP FLOW 2	J23	1	+24V
		2	Aout_Pump2_Flow
		3	Ground
PURGE 3 DC	J25	1	+24V
		2	Spare1_Sol
VD1	J26	1	AIN_VD-1
		2	Ground
VD2	J27	1	AIN_VD-2
		2	Ground
BOARD TEMP	J28	1	Board_Therm
		2	Ground
SPARE FLOW	J29	1	+24V
		2	Aout_Spare_Flow
		3	Ground
PURGE 4 DC	J30	1	+24V
		2	Spare2_Sol
PRESS BD	J31	1	-15V
		2	AIN_30PSIA
		3	AIN_FLOW_1
		4	AIN_VAC_2
		5	AIN_FLOW_2
		6	AIN_VAC_1
		7	+5V
		8	+15V
		9	Ground
PRESS TEMP	J32	1	Press_RTD
		2	Press_RTD
		3	Ground
CNTR WHEEL1	J33	1	+5V
		2	Ground
		3	Ground

Connector Label	Reference Designator	Pin	Signal Description
		4	VOA3
		5	+5V
BETA 1	J34	1	Ground
		2	+RS485
		3	-RS485
		4	Ground
		5	BATT_5V
		6	Ground
BETA 2	J35	1	Ground
		2	+RS485
		3	-RS485
		4	Ground
		5	BATT_5V
		6	Ground
LOAD MOTOR	J36	1	+24V
		2	Load_Motor_On
TAPE WHEEL2	J37	1	+5V
		2	Ground
		3	Ground
		4	+5V
		5	VO_CNTR2
CAM WHEEL1	J38	1	+5V
		2	Ground
		3	Ground
		4	Dig_Slit
		5	+5V
HWELL 1	J39	1	AIN_RTDP
		2	+5V
		3	AIN_RHP_Hum
		4	Ground
SAMPLE 2 TEMP	J40	1	Sample2A_RTD
		2	Sample2B_RTD
		3	Ground
SAMPLE 1 TEMP	J41	1	Sample1A_RTD
		2	Sample1B_RTD

Connector Label	Reference Designator	Pin	Signal Description
		3	Ground
TEST RTD	J42	1	SpareA_RTD
		2	SpareB_RTD
		3	Ground
AC IN	J43	1	AC+
		2	AC-
		3	AC-Ground
24V IN	J44	1	+24V
		2	Ground
DATA	J45	1	Ground
		2	+RS485
		3	-RS485
CAM WHEEL2	J46	1	+5V
		2	Ground
		3	Ground
		4	+5V
		5	VO_CAM2
BATT 5V IN	J47	1	BATT_5V
		2	Ground

Table 6–5. Front Panel Board Connector Pin Diagram

Connector Label	Reference Designator	Pin	Signal Description
MOTHERBOARD	J1	1	Ground
		2	Ground
		3	LCLK – LCD Signal
		4	Ground
		5	Ground
		6	LLP – LCD Signal
		7	LFLM – LCD Signal
		8	LD4 – LCD Signal
		9	LD0 – LCD Signal
		10	LD5 – LCD Signal
		11	LD1 – LCD Signal
		12	LD6 – LCD Signal

Connector Label	Reference Designator	Pin	Signal Description
		13	LD2 – LCD Signal
		14	LD7 – LCD Signal
		15	LD3 – LCD Signal
		16	LCD Bias Voltagel
		17	+5V
		18	Ground
		19	Ground
		20	LCD_ONOFF – LCD Signal
		21	Keypad Row 2 Input
		22	Keypad Row 1 Input
		23	Keypad Row 4 Input
		24	Keypad Row 3 Input
		25	Keypad Col 2 Select
		26	Keypad Col 1 Select
		27	Keypad Col 4 Select
		28	Keypad Col 3 Select
		29	Ground
		30	Ground
		31	Ground
		32	Ground
		33	+24V
		34	+24V
LCD DATA	J2	1	LD0_5V – LCD Signal
		2	LD1_5V – LCD Signal
		3	LD2_5V – LCD Signal
		4	LD3_5V – LCD Signal
		5	LCD_ONOFF_5V – LCD Signal
		6	LFLM_5V – LCD Signal
		7	NC
		8	LLP_5V – LCD Signal
		9	LCLK_5V – LCD Signal
		10	+5V
		11	Ground
		12	-25V
		13	LCD Bias Voltage

Connector Label	Reference Designator	Pin	Signal Description
		14	Ground
KEYBOARD	J3	1	Keypad Row 1 Input
		2	Keypad Row 2 Input
		3	Keypad Row 3 Input
		4	Keypad Row 4 Input
		5	Keypad Col 1 Select
		6	Keypad Col 2 Select
		7	Keypad Col 3 Select
		8	Keypad Col 4 Select
LCD BACKLIGHT	J4	1	+5V Supply
		2	NC
		3	Ground

Table 6–6. I/O Expansion Board (Optional) Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
EXPANSION I/O	J1	1	Analog Voltage Input 1
		2	Analog Voltage Input 2
		3	Analog Voltage Input 3
		4	Ground
		5	Analog Voltage Input 4
		6	Analog Voltage Input 5
		7	Analog Voltage Input 6
		8	Ground
		9	Analog Voltage Input 7
		10	Analog Voltage Input 8
		11	Ground
		12	NC
		13	Current Output Return
		14	Ground
		15	Current Output 1
		16	Current Output Return
		17	Current Output 2
		18	Current Output Return
		19	Current Output 3

Connector Label	Reference Designator	Pin	Signal Description
		20	Current Output Return
		21	Current Output 4
		22	Current Output Return
		23	Current Output 5
		24	Current Output Return
		25	Current Output 6
MOTHER BD	J2	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	+RS485 to Motherboard
		8	-RS485 to Motherboard

Table 6–7. Digital Output Board Connector Pin Descriptions

Connector Label	Reference Designator	Pin	Signal Description
MOTHER BD	J1	1	+5V
		2	+24V
		3	+24V
		4	Ground
		5	Ground
		6	Ground
		7	SPI Reset
		8	SPI Input
		9	SPI Output
		10	SPI Board Select
		11	SPI Clock
DIGITAL OUTPUTS	J2	1	Relay 1 Contact a
		2	Relay 2 Contact a
		3	Relay 3 Contact a
		4	Relay 4 Contact a
		5	Relay 5 Contact a

Connector Label	Reference Designator	Pin	Signal Description
		6	Relay 6 Contact a
		7	Relay 7 Contact a
		8	Relay 8 Contact a
		9	Relay 9 Contact a
		10	Relay 10 Contact a
		11	NC
		12	Solenoid Drive Output 1
		13	Solenoid Drive Output 2
		14	Solenoid Drive Output 3
		15	Solenoid Drive Output 4
		16	Solenoid Drive Output 5
		17	Solenoid Drive Output 6
		18	Solenoid Drive Output 7
		19	Solenoid Drive Output 8
		20	Relay 1 Contact b
		21	Relay 2 Contact b
		22	Relay 3 Contact b
		23	Relay 4 Contact b
		24	Relay 5 Contact b
		25	Relay 6 Contact b
		26	Relay 7 Contact b
		27	Relay 8 Contact b
		28	Relay 9 Contact b
		29	Relay 10 Contact b
		30	+24V
		31	+24V
		32	+24V
		33	+24V
		34	+24V
		35	+24V
		36	+24V
		37	+24V

Service Locations

For additional assistance, service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermo.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 7
Servicing

This chapter explains how to replace the Model 5028*i* subassemblies. It assumes that a subassembly has been identified as defective and needs to be replaced (or is an "expendable" item, not covered under warranty. Expendable items are indicated with an asterisk (*) in the "Model 5028i Replacement Parts" table.

For fault location information, refer to the "Preventive Maintenance" chapter and the "Troubleshooting" chapter in this manual.

The service mode section in the "Operation" chapter also includes parameters and functions that are useful when making adjustments or diagnosing problems.

For additional service assistance, see "Service Locations" at the end of this chapter.

This chapter includes the following parts information and component replacement procedures:

Safety Precautions

Read the safety precautions before beginning any procedures in this chapter.

WARNING The service procedures in this manual are restricted to qualified service representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

The detector assembly should be replaced by a qualified technician knowledgeable in dealing with radiation precautions. By removing the detector assembly, the C-14 radioactive source is partially exposed. Safety glassed must be worn during this replacement procedure. The amount of C-14 meets the USNRC regulations as an exempt amount of radioactive source <100 μCi. ▲

CAUTION The detector window is very fragile. Handle with great care and do not wipe or touch the window. Furthermore, do not touch the solder cable connection (electrode) with your bare fingers. The oils from your skin can damage the detector. ▲

Safety glasses must be worn while replacing the detector assembly. ▲

If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component (Figure 7–1). If an antistatic wrist strap is not available, be sure to touch the instrument chassis before touching any internal components. When the instrument is unplugged, the chassis is not at earth ground. ▲

Do not remove the LCD panel or frame from the LCD module. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

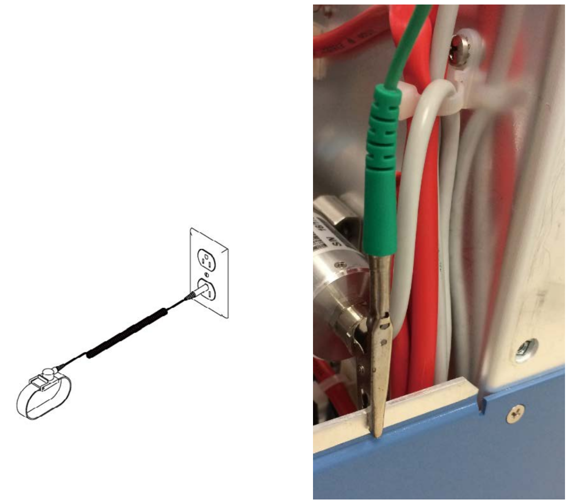


Figure 7–1. Properly Grounded Antistatic Wrist Strap

Firmware Updates

The firmware can be updated by the user in the field via the serial port or over the Ethernet. This includes both the main processor firmware and the firmware in all low-level processors. Refer to the *iPort* manual for the firmware update procedure.

Accessing the Service Mode

If the Service menu is not displayed on the Main Menu, use the following procedure to display it.

1. From the Main Menu, choose Instrument Controls > **Service Mode**.

   The Service Mode screen appears.

2. Press ↵ to toggle the Service Mode to ON.

3. Press ■ > ■ to return to the Main Menu.

4. Return to the procedure.

Replacement Parts List

Table 7–1 lists the replacement parts for the Model 5028*i* major subassemblies. Refer to Figure 7–2 to identify the component location.

Table 7–1. Model 5028*i* Replacement Parts

Part Number	Description
100480-00	Front Panel Pushbutton Board
110570-00	Processor Board (new *i*Port and *.cramfs required)
109141-00	Motherboard
100539-00	Digital Output Board
100542-00	I/O Expansion Board (optional)
102340-00	Front Panel Connector Board
102496-00	Front Panel Display
CIC0001569	Assy, XFMR & Mounting Plate (optional)
CIC0000718	Dual Channel MIB Board
105869-00	Detector Assembly (LND4335)
105938-00	Photo Interrupt Board Assembly
CIC0002410	Extension Cable, RTD
106536-00	RH Temperature Assembly
CIC0001583	Assy, Heater Tube, Three Feet
CIC0001575	Assy, Cam Motor W/Coupling
CIC0001486	Tape Motor Assembly
106470-00	Proportional Valve Assembly
CIC0001585	Pressure Board Tubing Assy
CIC0000720	Assembly Dual Channel Pressure Board
CIC0002250	Detector AMP, CH1
CIC0002251	Detector AMP, CH2
106923-00	Pressure Valves
106540-00	Extension tubes 6’ LG w/fitting
CIC0002346	TB, FIN. 5/8 ODX.495 IDX3’ LG
CIC0002347	TB, FIN. 5/8 ODX.495 IDX4’ LG
CIC0002348	TB, FIN. 5/8 ODX.495 IDX8’ LG
CIC0002349	TB, FIN. 5/8 ODX.495 IDX10’ LG
CIC0002412	INSUL,1/2 ID X 1.0 WALL,3FT LG
CIC0002413	INSUL,1/2 ID X 1.0 WALL,4FT LG
CIC0002414	INSUL,1/2 ID X 1.0 WALL, 8FT LG
CIC0002415	INSUL,1/2 ID X 1.0 WALL, 10FT LG
107000-00	FTG,UNION 5/8 W/TEFLON FERRULE
101055-00	AC Receptacle Assembly

Part Number	Description
101681-00	Power Supply Assembly, 24 VDC (with base plate and screws)
111037-00	Assy 5014i Thermistor
100907-00	Fan, 24 VDC
8630	Filter Guard Assembly (with foam)*
103995-00	Fuse, 250 VAC, 7.0 Amp, SlowBlow (for 100-120 VAC models)* TLHG—Time delay high capacity
109613-00	Fuse, 250 VAC, 5.0 Amp, SlowBlow (for 220-240 VAC models)* TLHG—Time delay high capacity
CIC0001827	PUMP, VAC, 230V, 50/60HZ
59-008630	Pump Rebuild Kit
24-000483	Pump Tubing, External 3/8-inch
106994-00	Tubing, Internal 3/8-inch
CIC0002235	Tape Roller
KT149248091	Filter Tape
108183-00	Tape Hardware Kit
112297-00	Replacement O-ring Kit
CIC0002271	Top cover assy
CIC0001584	Handles
FH125C14	Calibration Kit (Cal Foils)
10-000447	Modified Shoe for Tripod
106445-00	Metal Assembly Paste
107001-00	Tubing, 5/8 Stainless Steel
FH118C	Inlet Adapter Tube
109583-00	Roof Flange Assembly

*Expendable item, not covered by warranty

Cable List

Table 7–2 lists the Model 5028*i* cables. See the "Troubleshooting" chapter for associated connection diagrams and board connector pin descriptions.

Table 7–2. Model 5028*i* Cables

Part Number	Description
101349-00	AC Power Cable (115 VAC, US)
107315-00	AC Power Cable (220 VAC, China)
8926	AC Power Cable (220 VAC, EU)
101036-00	DC Power Supply 24 V Output
101037-00	Cable Assy, AC cable to Measurement Interface Board

Part Number	Description
101048-00	RS-485/Data
101038-00	AC Power Switch to Motherboard
101364-00	DC Power Supply Status Monitor
101035-00	DC Power Supply AC Input
101055-00	Main AC from Receptacle Assembly
101377-00	AC to Power Switch
101267-00	Fan Power Assembly
106028-00	RH Temperature Connector Assembly
1518038	CABLE, COAXIAL, 20AWG
110453-00	Assy, Cable External Mac Valve
CIC0001478	Cable ASSY, Cam Photo
CIC0001483	Cable Assy, Pressure Board
CIC0001486	Cable Assy, Spindle Motor
CIC0001488	Cable Assy, Pump power
CIC0001489	Cable Assy, Channel A Heater
CIC0001499	Cable Assy, BCB IN & MIB
CIC0001500	Cable Assy, BCB OUT & MIB
CIC0001815	AMP EXTEND CABLE CHANNEL A
CIC0001821	ASSEMBLY, RIBBON CABLE
CIC0002232	GND wire
CIC0001569	ASSY,XFMR & MOUNTING PLATE
106033-00	ASSY, CBL, IQ VALVE TO MIB
106844-00	ASSY CBL,REAR SOL VALVE/INTFC
106400-00	ASSY, CBL, EXTERNAL RH/TEMP
111037-00	Assy 5014i Thermistor
CIC0002410	EXTENTION CABLE, RTD
106400-00	External RH Temperature Cable Assembly

External Device Connection Components

Table 7–3 lists the standard and optional cables and components used for connecting external devices such as PCs and dataloggers to an iSeries instrument.

Table 7–3. External Device Connection Components

Part Number	Description
102562-00	Terminal Block and Cable Kit (DB25) (optional)
102556-00	Terminal Block and Cable Kit (DB37) (optional)

Part Number	Description
102645-00	Cable, DB37M to Open End Cable, Six Feet (optional)
102646-00	Cable, DB37F to Open End, Six Feet (optional)
102659-00	Cable, DB25M to Open End, Six Feet (optional)
6279	Cable, RS-232, Six Feet (optional)
102888-00	Terminal Board PCB Assembly, DB37F (standard)
102891-00	Terminal Board PCB Assembly, DB37M (standard)
103084-00	Terminal Board PCB Assembly, DB25M (included with optional I/O Expansion Board)

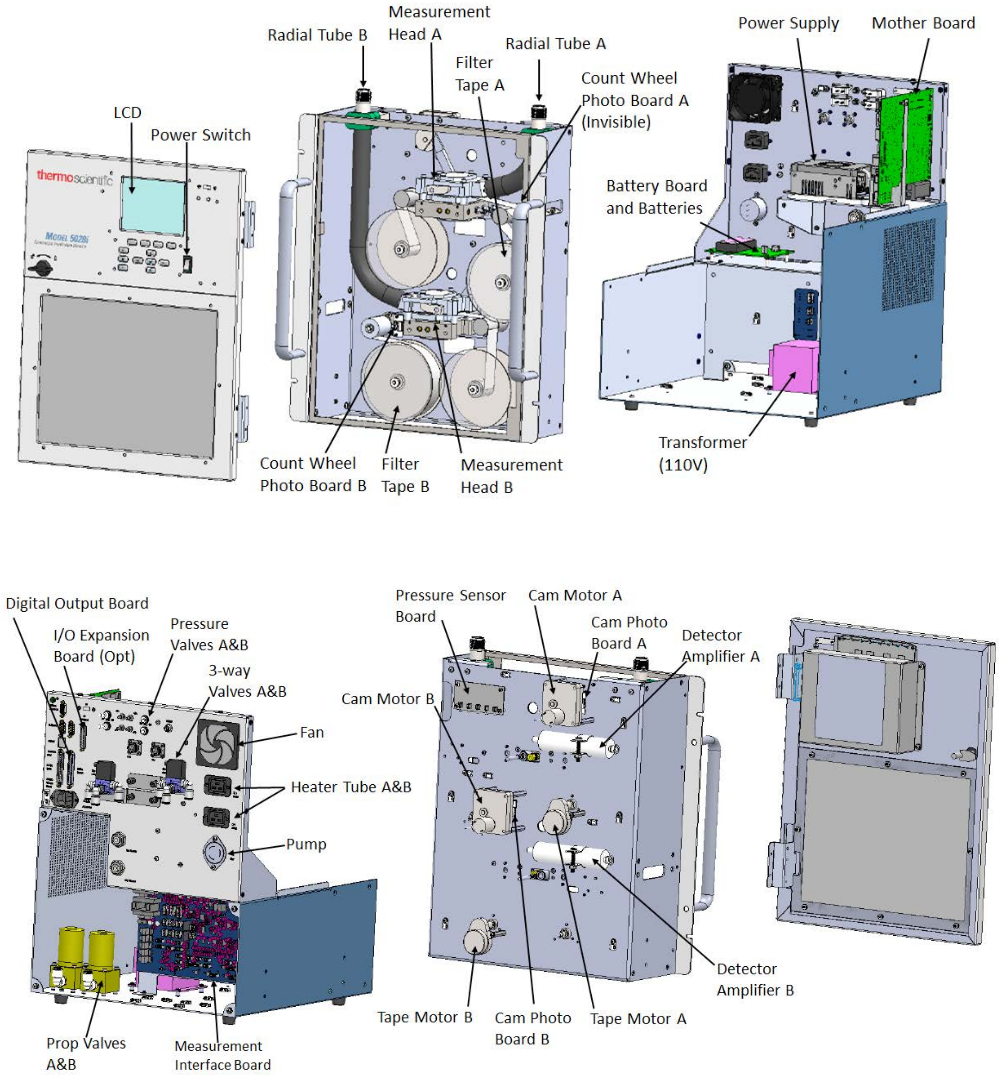


Figure 7–2. Model 5028*i* Component Layout

Removing the Measurement Case Assembly and Rear Panel

The measurement case assembly and the rear panel to can be removed improve access to connectors and components. Refer to the following steps when a procedure requires remove the case and rear panel (Figure 7–3).

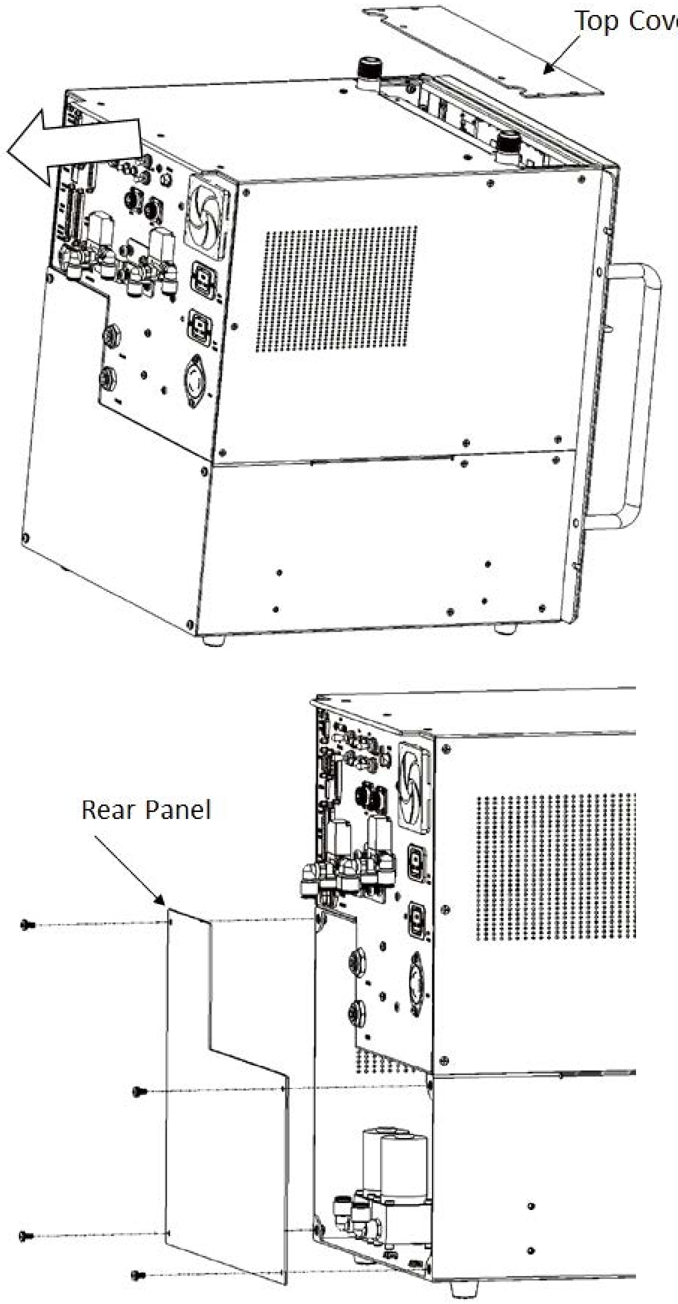


Figure 7–3. Removing the Measurement Case Assembly and Rear Panel

Equipment Required:

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF and unplug the power cord.
2. If the instrument is mounted in a rack, you can remove the screws which connect the small upper cover to measurement case. Don't need to disconnect heated tube fittings on the upper of instrument.
3. Remove five screws from the top side of the case (viewed from the front).
4. Remove 14 srews on the left and right side of measurement case.
5. Pull the measurement case from rear side of instrument.
6. Remove the 4 screws on the rear panel, then you can take off the rear panel from back side.
7. While a seriously and fully service needed, you can disconnect the fittings between instrument and heated tube. Pull the instrument out of the rack.
8. Install the measurement case assembly by following the previous steps in reverse.

Fuse Replacement

Use the following procedure to replace the fuse.

Equipment Required:

Replacement fuses (refer to the "Replacement Parts List" in this chapter).

1. Turn the instrument OFF and unplug the power cord.
2. Remove the fuse drawer, located on the AC power connector.
3. If either fuse is blown, replace both fuses.
4. Insert fuse drawer and re-connect power cord.

Fan/Filter Replacement

Use the following procedure to replace the fan and the fan filter (Figure 7–4).

Equipment Required:

Fan

Fan filter

Philips screwdriver

Cable cutter (for tie-wrap removal)

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Remove the fan guard and filter from the fan by unsnapping it.
3. If the fan is not being replaced, install the new filter, and snap it back into place, and skip the remaining steps.
4. Disconnect the fan power cable from the fan. Do not lose the four nuts.
5. Remove the four fan mounting screws and remove the fan.
6. Install a new fan following the previous steps in reverse.

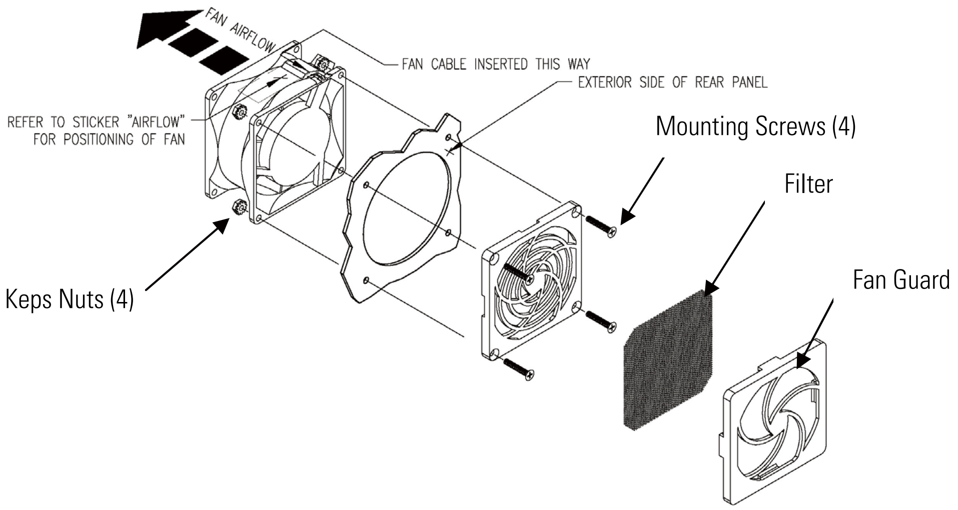


Figure 7–4. Replacing the Fan

Detector Amplifier Assembly Replacement

Use the following procedure to replace the detector/preamplifier assembly (Figure 7–5).

Equipment Required:

Detector amplifier assembly

Philips screwdriver

Adjustable wrench

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the cable from the detector amplifier assembly connector on the measurement interface board and disconnect the SHV connector from the detector amplifier.

3. Remove the one screw holding the detector amplifier mounting bracket and slide out the detector amplifier assembly.

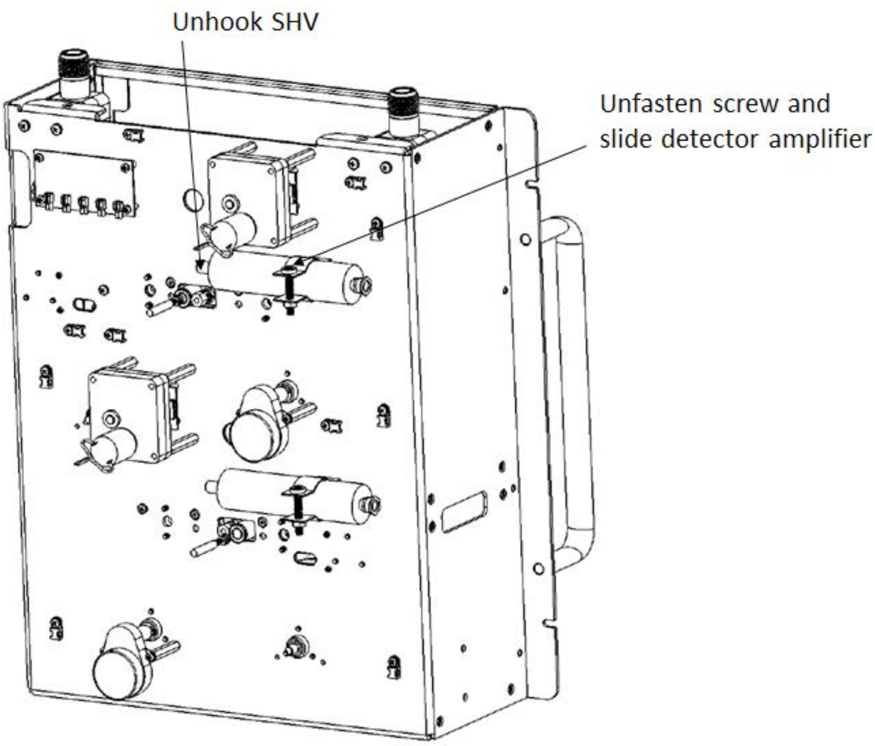


Figure 7–5. Replacing the Detector Amplifier Assembly

4. Install the new detector amplifier assembly by following the previous steps in reverse.

5. Be sure to the new detector amplifier assembly connect to the right measurement head. The detector amplifier A couldn't be replaced by detector amplifier B, and vice versa.

6. Calibrate the detector amplifier board. Refer to the "Detector Amplifier Board Calibration" procedure that follows.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

7. Calibrate the instrument. Refer to the "Calibration" chapter in this manual.

Detector Amplifier Board Calibration

Calibrate the detector amplifier after replacing the detector amplifier board.

Note This adjustment should only be performed by an instrument service technician. ▲

1. Let the instrument sample zero air for about 90 minutes.

2. From the Main Menu, choose Service > Detector Calibration > **Auto**.

   The Auto Detector Calibration screen appears.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

3. At the Detector Calibration screen, press ↵ to start the auto detector calibration.

External Pump Replacement

Use the following procedure to replace the pump (Figure 7–6).

Equipment Required:

Pump

Adjustable wrench

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord by anticlockwise turning.
2. Disconnect the pump power cable from the rear panel.
3. Remove green gas line from the pump which connect to the plastic tee joint of rear panel
4. Install the new pump by following the previous steps in reverse.
5. Perform a leak test as described in the "Preventive Maintenance" chapter.

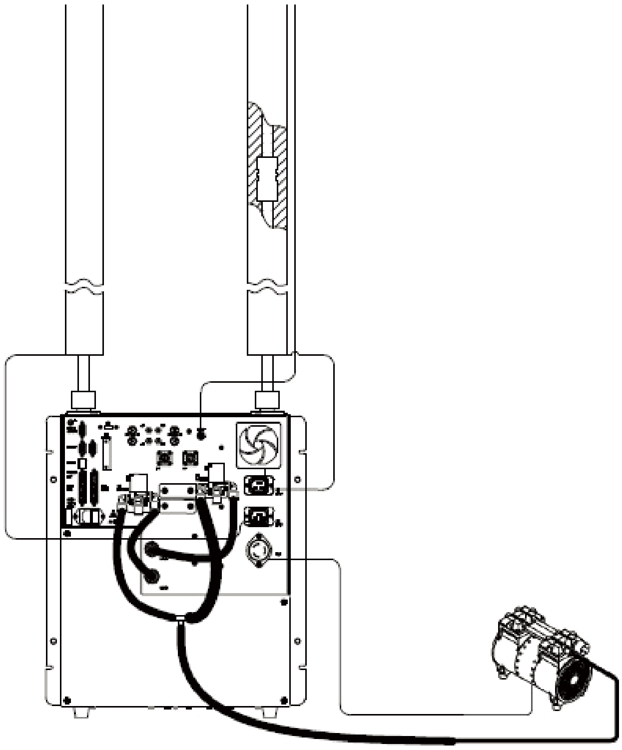


Figure 7–6. Replacing the Pump

Pressure Board Replacement

Use the following procedure to replace the pressure board (Figure 7–7).

Equipment Required:

Pressure board

Philips screwdriver, #2

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect plumbing from the pressure board assembly (Figure 7–2). Note the plumbing connections to facilitate reconnection.
3. Disconnect the pressure board from the floor plate on the measurement interface board.
4. Remove the four pressure board assembly retaining screws and remove the pressure board assembly (Figure 7–7).

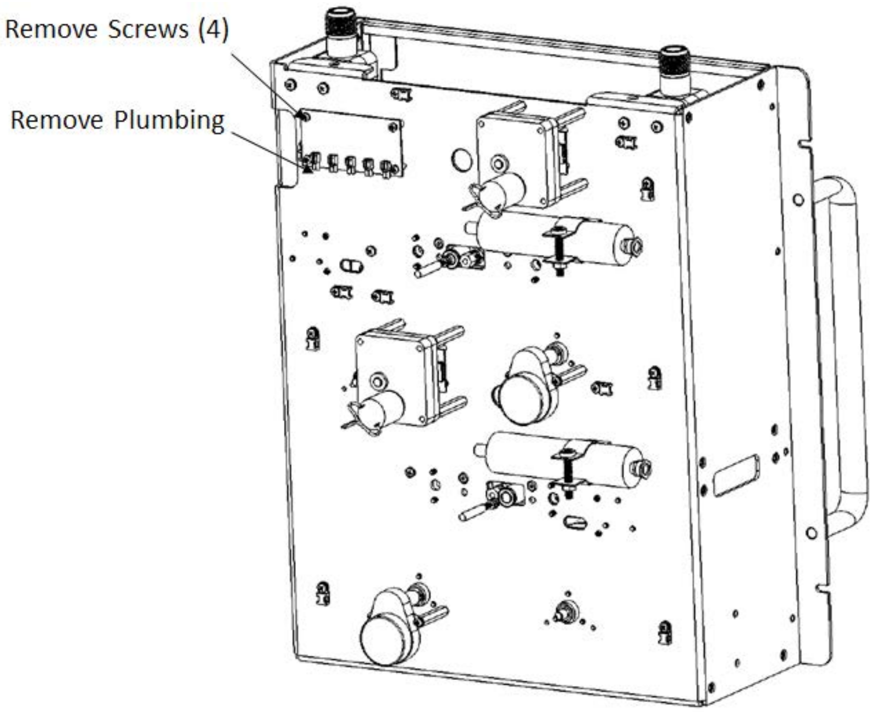


Figure 7–7. Replacing the Pressure Board Assembly

5. To install the pressure board assembly, follow the previous steps in reverse.

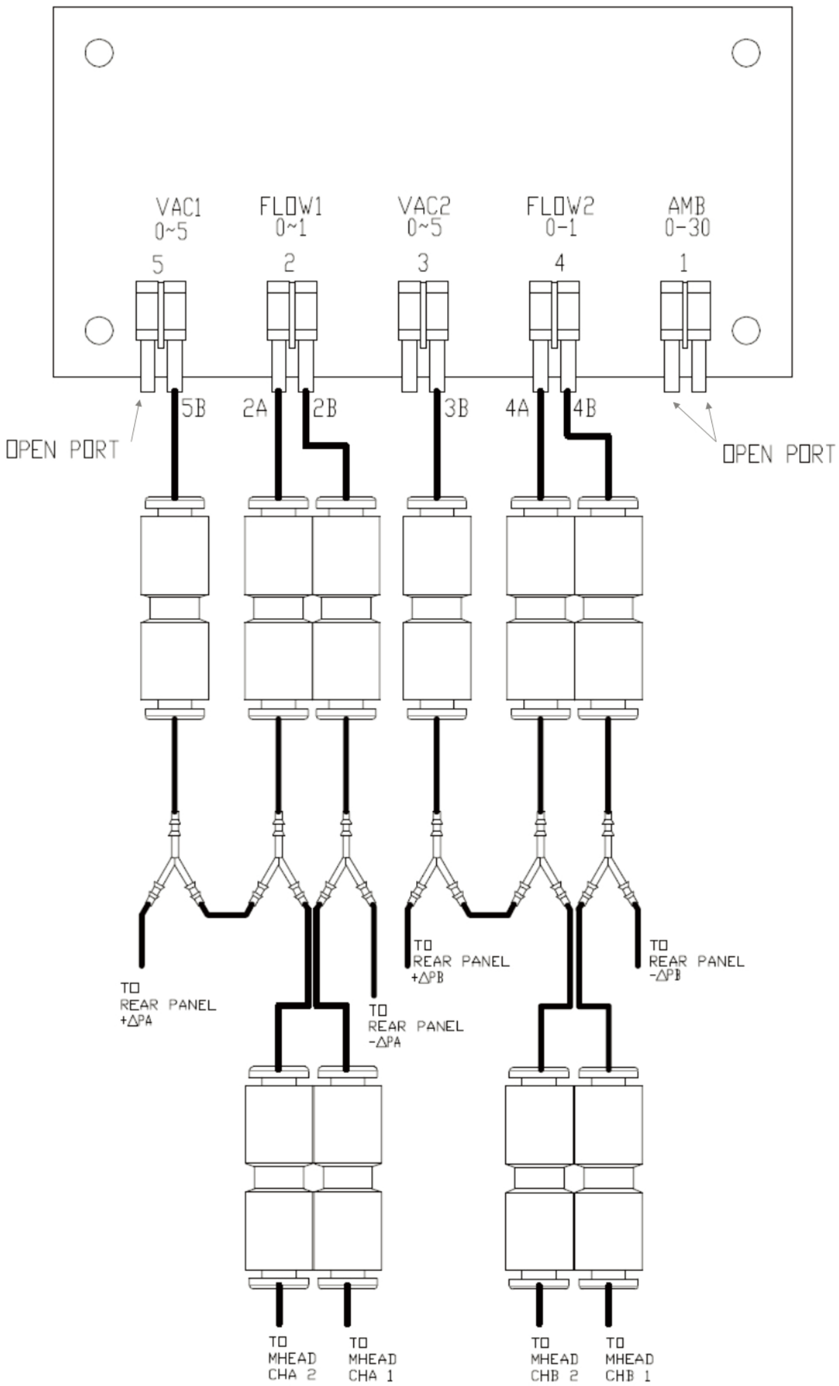


Figure 7–8. Replacing the Pressure Board Assembly Plumbing Connection

6. Calibrate the pressure sensor. Refer to the "Pressure Board Calibration" procedure that follows.

7. After calibration, perform a leak test as described in the "Preventive Maintenance" chapter.

Pressure Board Calibration

Use the following procedure to calibrate the pressure board assembly.

Equipment Required:

Manometer

1. From the Main Menu, choose Service > Pres/Vacuum Calibration > **Baro Pres**. Adjust the barometer pressure span by entering the actual barometric pressure value.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

2. Return to the Pres/Vacuum Calibration, choose Vac/Flow > **Flow Pres Span**. Calibrate the flow pressure span according to the following:
   a. Place digital manometer on bench.
   b. Turn on manometer and allow to self calibrate. **Do not move** manometer while self-calibrating.
   c. After zeroing the digital manometer, calibrate Channel A firstly, connect the "+" side of the manometer to the +ΔPA port on the rear panel.
   d. Connect the "–" side of the manometer to the -ΔPA port on the rear panel.
   e. Open both +ΔPA and –ΔPA toggle valves to open flow through the manometer.
   f. Cal Flow Pres Span by entering the actual value read by the manometer.
   g. Press ↵ to save value.
   h. Turn off the manometer; this meter does not have an automatic turn off feature.
3. Return to the Pres/Vacuum Calibration, choose Vac/Flow > **Vac Pres Span**. Calibrate the vacuum pressure span according to the following:
   a. Use an acceptable vacuum manometer. If using a blue Druck manometer, place blue manometer on bench.
   b. Turn on manometer and let manometer self calibrate. **Do not move** manometer while self-calibrating.
   c. Connect the "+" side of the manometer to the +ΔPA port on the rear panel.
   d. Open +ΔPA toggle valve to open flow through the manometer. -ΔPA toggle valve is on OFF position.

e. Cal Vac Pressure Span by entering the actual value from the reference manometer.

f. Press [↵] to save value.

4. Pres/Vacuum Calibration of Channel B has the same process as Channel A. Need to notice that the manometer should connect to the ΔPB ports on the rear panel.

Analog Output Testing

The analog outputs should be tested if the concentration value on the front panel display disagrees with the analog outputs. To check the analog outputs, connect a meter to an analog output channel (voltage or current) and compare the meter reading with the output value set on the Test Analog Outputs screen.

Equipment Required:

Multimeter

Use the following procedure to test the analog outputs.

1. Connect a meter to the channel to be tested. Figure 7–9 shows the analog output pins and Table 7–4 identifies the associated channels.

2. From the Main Menu, choose Diagnostics > **Test Analog Outputs**.

   The Test Analog Outputs screen appears.

3. Press [↓] to scroll to the desired channel corresponding to the rear panel terminal pins where the meter is connected, and press [↵].

   The Set Analog Outputs screen appears.

4. Press [↓] to set the output to zero.

   The Output Set To line displays Zero.

5. Check that the meter is displaying the zero value. If the meter reading differs by more than one percent of the full-scale output, the analog outputs should be adjusted. Refer to the "Analog Output Calibration" procedure that follows.

6. Press [↑] to set the output to full-scale.

   The Output Set To line displays Full-Scale.

7. Check that the meter is displaying a full-scale value. If the meter reading differs by more than one percent of the full-scale output, the analog outputs should be adjusted. Refer to the "Analog Output Calibration" procedure that follows.

8. Press [↵] to reset the analog outputs to normal.

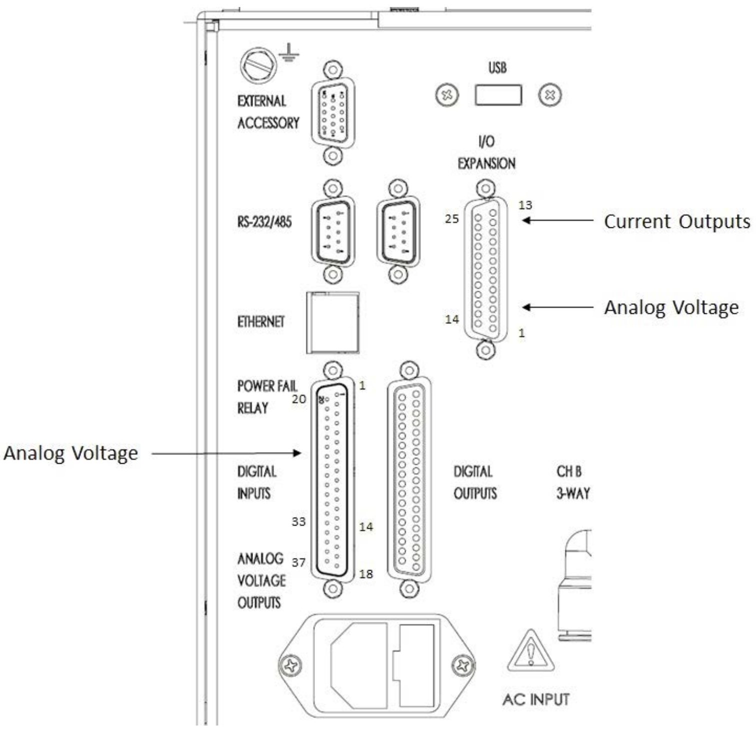


Figure 7–9. Rear Panel Analog Input and Output Pins

Table 7–4. Analog Output Channels and Rear Panel Pin Connections

Voltage Channel	Pin	Current Channel	Pin
1	14	1	15
2	33	2	17
3	15	3	19
4	34	4	21
5	17	5	23
6	36	6	25
Ground	16, 18, 19, 35, 37	Current Output Return	13, 16, 18, 20, 22, 24

Table 7–5. Analog Input Channels and Rear Panel Pin Connections

Input Channel	Pin
1	1
2	2
3	3
4	5
5	6
6	7

Input Channel	Pin
7	9
8	10
Ground	4, 8, 11, 14

Analog Output Calibration

Use the following procedure to calibrate the analog outputs if a meter reading in the "Analog Output Testing" procedure differed by more than one percent or after replacing the optional I/O expansion board.

Equipment Required:

Multimeter

1. Connect a meter to the channel to be adjusted and set to voltage or current as appropriate. Figure 7–9 shows the analog output pins and Table 7–4 identifies the associated channels.

2. From the Main Menu, choose Service > **Analog Out Cal**.

   The Analog Output Cal screen appears.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

3. At the Analog Output Cal menu, press to scroll to the desired voltage channel or current channel corresponding to the rear panel terminal pin where the meter is connected, then press .

4. With the cursor at Calibrate Zero, press .

   The Analog Output Cal line displays Zero.

Note When calibrating the analog output, always calibrate zero first and then calibrate full-scale. ▲

5. Use until the meter reads the value shown in the Set Output To line (0.0 V, or 0.0 or 4.0 mA), then press to save the value.

6. Press to return to the previous screen.

7. Press to select Calibrate Full-Scale.

8. Use until the meter reads the value shown in the Set Output To line, then press to save the value.

Analog Input Calibration

Use the following procedures to calibrate the analog inputs after replacing the optional I/O expansion board. These procedures include selecting analog input channels, calibrating them to zero volts, and then calibrating them to full-scale using a known voltage source.

Calibrating the Input Channels to Zero Volts

Use the following procedure to calibrate the input channels to zero volts.

1. From the Main Menu, choose Service > **Analog Input Cal**.

   The Analog Input Cal screen appears.

Note If Service Mode is not displayed, refer to "Accessing the Service Mode" on page 7-4, then return to the beginning of this step. ▲

2. At the Analog Input Cal screen, press [⬇] to scroll to a channel, and press [↩].
3. With the cursor at Calibrate Zero, press [↩].

   The screen displays the input voltage for the selected channel.

4. Make sure that nothing is connected to the channel input pins and press [↩] to calibrate the input voltage on the selected channel to zero volts.

   The screen displays 0.00 V as the voltage setting.

5. Press [◼] > [◼] to return to the Analog Input Cal screen and repeat Steps 2 through 4 to calibrate other input channels to zero as necessary.
6. Continue with the "Calibrating the Input Channels to Full-Scale" procedure that follows.

Calibrating the Input Channels to Full-Scale

Use the following procedure to calibrate the input channels to full-scale by applying a known voltage to the channels.

Equipment Required:

DC voltage source (greater than 0 volts and less than 10 volts)

1. Connect the known DC voltage source to the input channel (1-8) to be calibrated. Figure 7–9 shows the analog input pins and Table 7–5 identifies the associated channels.
2. From the Main Menu, choose Service > **Analog Input Cal**.

   The Analog Input Cal screen displays input channels 1-8.

3. At the Analog Input Cal screen, press [⬇] to scroll to the channel selected in Step 1, and press [↩].

4. Press [↓] to scroll to Calibrate Full-scale, and press [↵].

   The screen displays the input voltage for the selected channel.

5. Use [←] [→] and [↑] [↓] to enter the source voltage, and press [↵] to calibrate the input voltage for the selected channel connected to the source voltage.

6. Press [■] > [■] to return to the input channels display and repeat Steps 3-5 to calibrate other input channels to the source voltage as necessary.

Thermistor Replacement

Use the following procedure to replace the optional ambient temperature thermistor (Figure 7–10).

Equipment Required:

Thermistor assembly

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Squeeze the thermistor latch and pull the thermistor assembly from the AMB TEMP connector on the measurement interface board.

3. Snap the new thermistor into the AMB TEMP connector.

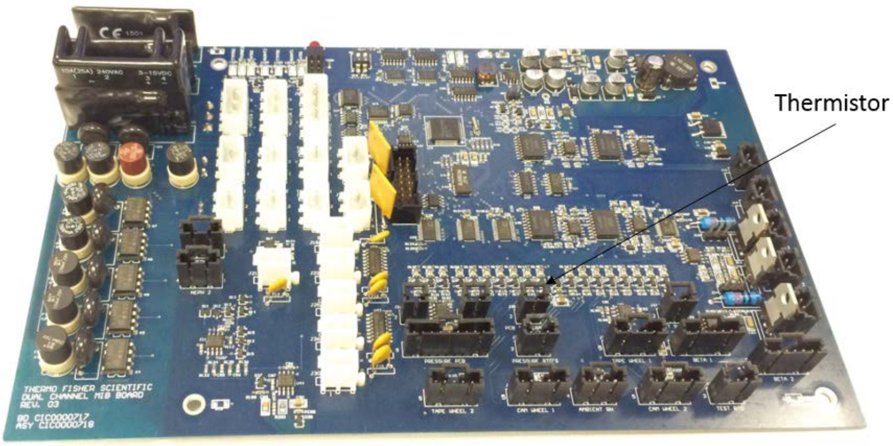


Figure 7–10. Replacing the Thermistor

I/O Expansion Board (Optional) Replacement

Use the following procedure to replace the optional I/O expansion board (Figure 7–11).

Equipment Required:

I/O expansion board

Nut driver, 3/16-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Unplug the I/O expansion board cable from the EXPANSION BD connector on the motherboard.
3. Remove the two standoffs holding the I/O expansion board connector to the rear panel (Figure 7–12).
4. Pop the board off of the mounting studs and remove the board.
5. To install the I/O expansion board, follow the previous steps in reverse.
6. Calibrate the analog current outputs and analog voltage inputs as defined earlier in this chapter.

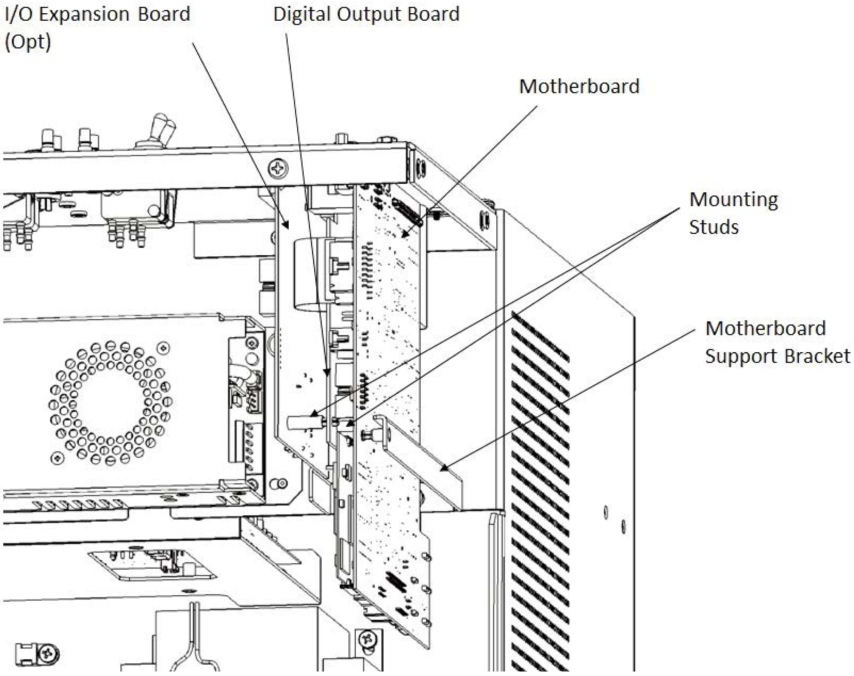


Figure 7–11. Replacing the I/O Expansion Board (Optional)

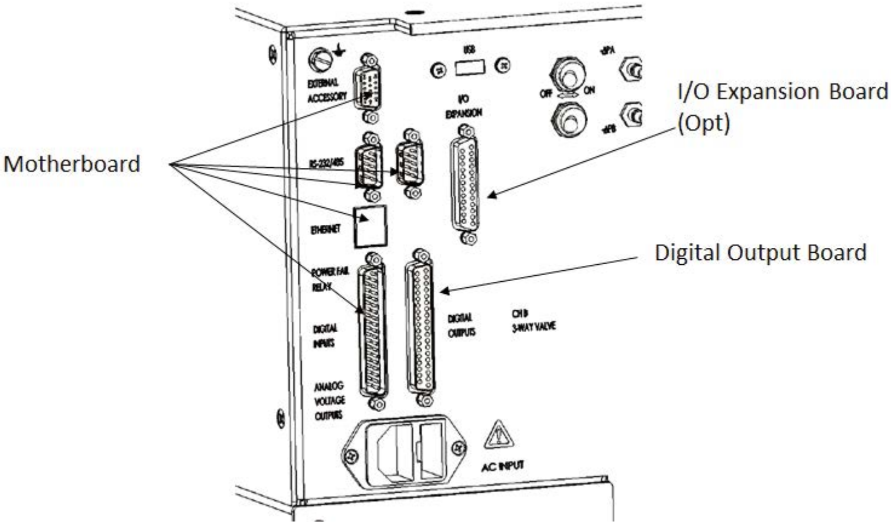


Figure 7–12. Rear Panel Board Connectors

Digital Output Board Replacement

Use the following procedure to replace the digital output board (Figure 7–11).

Equipment Required:

Digital output board

Nut driver, 3/16-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Remove the I/O expansion board (optional), if used. See the "I/O Expansion Board (Optional) Replacement" procedure in this chapter.
3. Disconnect the digital output board ribbon cable from the motherboard.
4. Using the nut driver, remove the two standoffs securing the board to the rear panel (Figure 7–12).
5. Pop the digital output board off of the mounting studs and remove the board.
6. To install the digital output board, follow the previous steps in reverse.

Motherboard Replacement

Use the following procedure to replace the motherboard (Figure 7–11).

Equipment Required:

Motherboard

Philips screwdriver

Nut driver, 3/16-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Remove the I/O expansion board (optional), if used. See the "I/O Expansion Board (Optional) Replacement" procedure in this chapter.
3. Remove the digital output board. See the "Digital Output Board Replacement" procedure in this chapter.
4. Unplug all connectors from the motherboard. Note connector locations to facilitate re-connection.
5. Using the nut driver, remove the six standoffs securing the board to the rear panel (Figure 7–12).
6. Pop the motherboard off of the support bracket, and remove the motherboard.
7. To install the motherboard, follow the previous steps in reverse.
8. Calibrate the analog voltage outputs as defined earlier in this chapter (all ranges).

Measurement Interface Board Replacement

Use the following procedure to replace the measurement interface board (Figure 7–13).

Equipment Required:

Measurement interface board

Philips screwdriver

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Lower the partition panel, then proceed to the next step below. Refer to "Removing the Measurement Case Assembly and Rear Panel" in this chapter.

2. Unplug all connectors from the measurement interface board. Note the locations of the connectors to facilitate re-connection.
3. Unscrew the two screws at the top of the measurement interface board. Pop the measurement interface board off from the two bottom mounting studs and remove the board.
4. To install the measurement interface board, follow the previous steps in reverse.
5. Re-install the measurement case assembly.
6. Calibrate the instrument. Refer to the "Calibration" chapter in this manual.

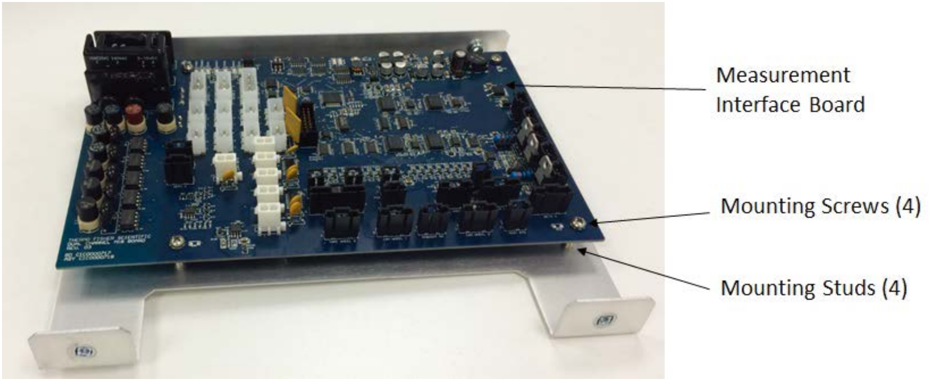


Figure 7–13. Replacing the Measurement Interface Board

Photo Interrupt Board Replacement

Use the following procedure to replace the photo interrupt board (Figure 7–14).

Equipment Required:

Photo interrupt board

Hex driver, 3/32-inch

Philips head screwdriver, #1

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect cable.
3. Remove mounting screws.
4. Remove board.
5. Re-install the photo interrupt board by following the previous steps in reverse.

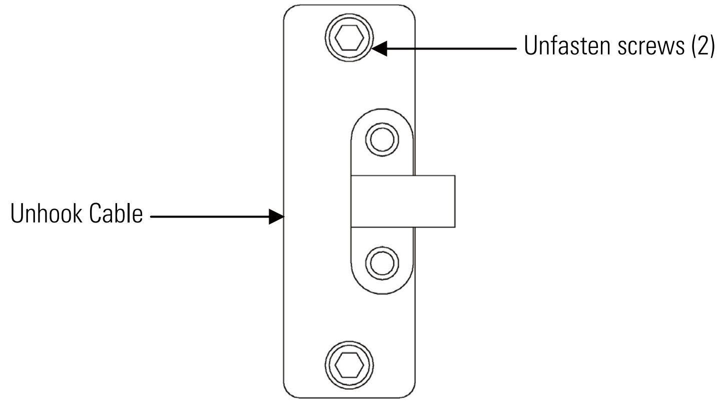


Figure 7–14. Replacing the Photo Interrupt Board

Proportional Valve Replacement

Use the following procedure to replace the proportional valve (Figure 7–15).

Equipment Required:

Proportional valve assembly

Hex driver, 3/32-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Refer to "Removing the Measurement Case Assembly and Rear Panel" in this chapter to lower the partition panel, then proceed to the next step below.
3. Disconnect connector from the measurement interface board.
4. Disconnect plumbing.
5. Remove four mounting screws and remove proportional valve assembly.
6. Replace the proportional valve assembly by following the previous steps in reverse.
7. Perform a leak test as described in the "Preventive Maintenance" chapter.

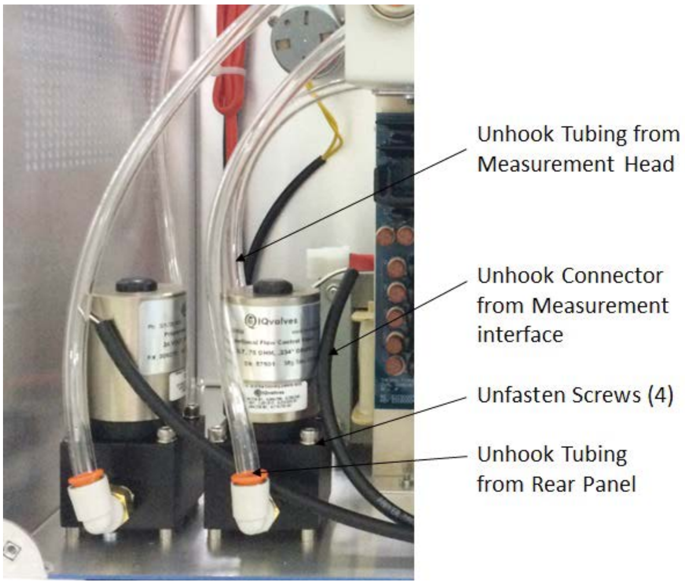


Figure 7–15. Replacing the Proportional Valve

Detector Assembly Replacement

Use the following procedure to replace the detector assembly (Figure 7–16).

Equipment Required:

Detector assembly

Hex driver, 4 mm

Safety glasses

WARNING The detector assembly should be replaced by a qualified technician knowledgeable in dealing with radiation precautions.
By removing the detector assembly, the C-14 radioactive source is partially exposed. Safety glassed must be worn during this replacement procedure. The amount of C-14 meets the USNRC regulations as an exempt amount of radioactive source <100 µCi. ▲

The service procedures in this manual are restricted to qualified representatives. ▲

If the equipment is operated in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. ▲

CAUTION The detector window is very fragile. Handle with great care and do not wipe or touch the window. Furthermore, do not touch the solder cable connection (electrode) with your bare fingers. The oils from your skin can damage the detector. ▲

Safety glasses must be worn while replacing the detector assembly. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Disconnect the SHV connector from the detector amplifier assembly and slide throught the wall plate.
3. Loosen both detector mounting screws and slowly lift the detector assembly.
4. Install the new detector assembly by following the previous steps in reverse, while taking special care not to puncture the mylar.
5. Calibrate the detector assembly. Refer to the "Detector Calibration" procedure on page 4-10.

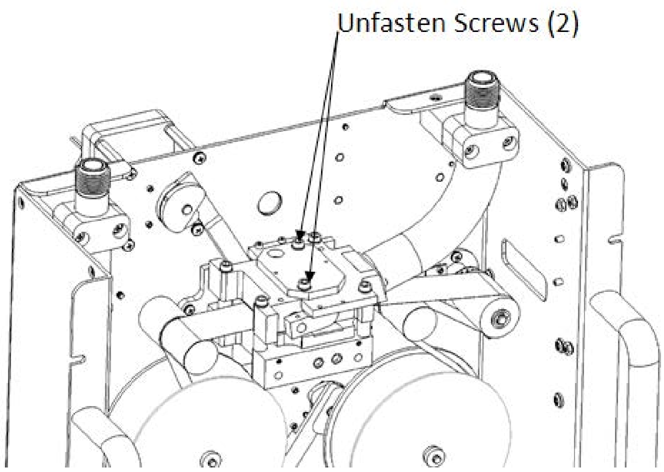


Figure 7–16. Replacing the Detector Assembly

Flow RTD Replacement

Use the following procedure to replace the flow resistive temperature diction (RTD) (see Figure 7–17).

Equipment Required:

Sample flow RTD

Adjustable wrench

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the

cover.

2. Refer to "Removing the Measurement Case Assembly and Rear Panel" in this chapter to lower the partition panel, then proceed to the next step below.
3. Loosen the kynar fittings using the wrench and slide out sample flow RTD.
4. Unplug the RTD connector from the measurement interface board "flowtemp1".
5. Carefully install the new RTD by following the previous steps in reverse. Match the marked black line on the RTD to be flush with the fitting.

Note The black line is the pre-measured depth for the RTD. ▲

6. Calibrate the instrument. Refer to the "Calibration" chapter in this manual.

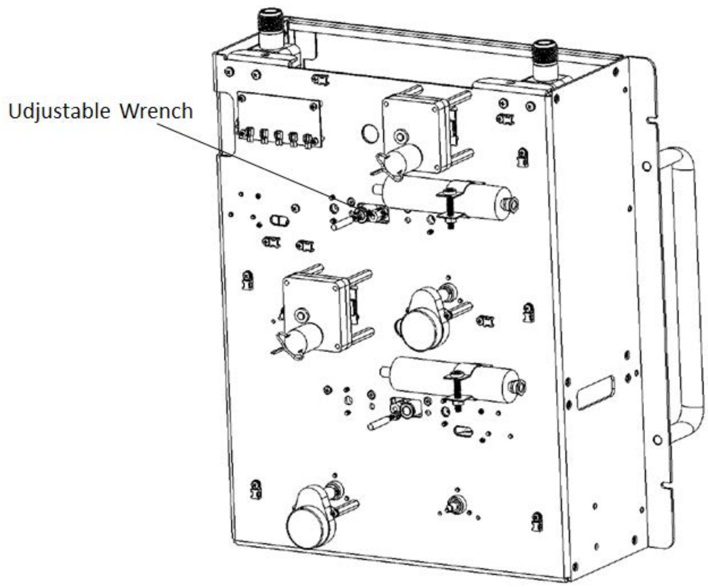


Figure 7–17. Replacing the RTD

Transformer Replacement

Use the following procedure to replace the transformer (Figure 7–18).

Equipment Required:

Transformer assembly

Philips screwdriver, #2

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the

cover.

2. Disconnect cables from the measurement interface board and motherboard.
3. Unscrew the four mounting screws and lift out the transformer assembly.
4. Install the new transformer by following the previous steps in reverse.

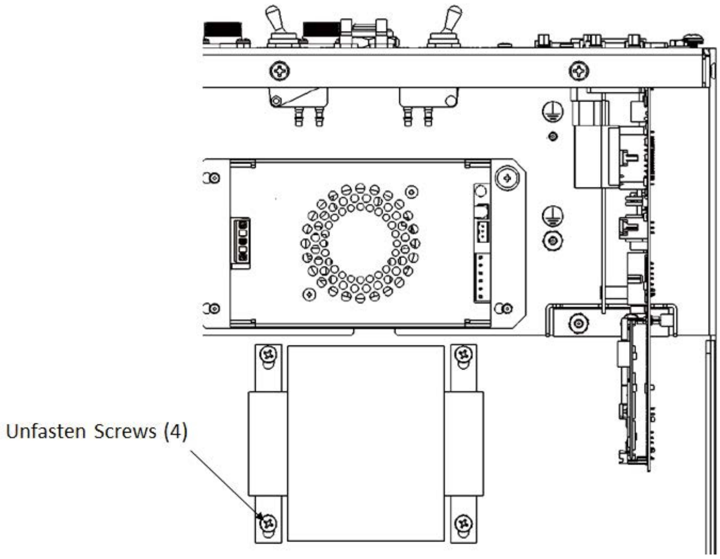


Figure 7–18. Replacing the Transformer

Radius Tube Replacement

Use the following procedure to replace the radius tube (Figure 7–19).

Equipment Required:

Radius tube assembly

Hex driver, 9/16-inch

Hex driver, 7/64-inch

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover. Channel A and Channel B have the same operation for replacement.
2. Loosen the two screws of the radius mounting block using a 9/16-inch hex driver.
3. Loosen the two mounting screws on the measurement head assembly. Remove tube by slightly turning side-to-side, while pulling.

4. Verify the sealing o-ring is in position before sliding the new radius tube assembly into the measurement head.
5. Install the new radius tube assembly by following the previous steps in reverse.

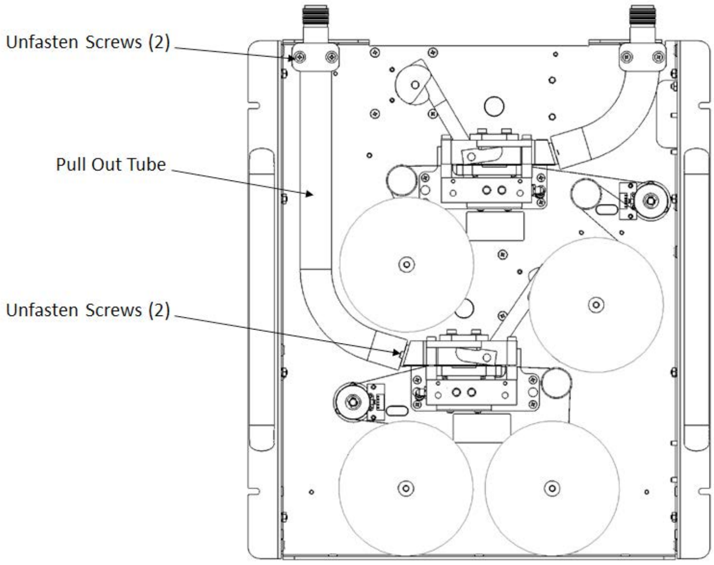


Figure 7–19. Replacing the Radius Tube

Ambient RH/Temp Replacement

Use the following procedure to replace the ambient RH/temperature assembly (Figure 7–20).

Equipment Required:

Ambient RH/temperature assembly

Adjustable wrench

Pliers

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.
2. Remove the cable from the bottom of the radiation shield assembly that houses the ambient RH/temperature assembly.
3. Remove the two mounting nuts on the mounting clamp of the radiation shield assembly. Remove the radiation shield assembly.
4. Turn over the radiation shield assembly and remove the three thumb screws.
5. Remove the three spacers and mounting bracket.
6. Slide out the ambient RH/temperature assembly.

7. Slide in the new ambient RH/temperature assembly by following the previous steps in reverse.

8. Calibrate the instrument. Refer to the "Calibration" chapter in this manual.

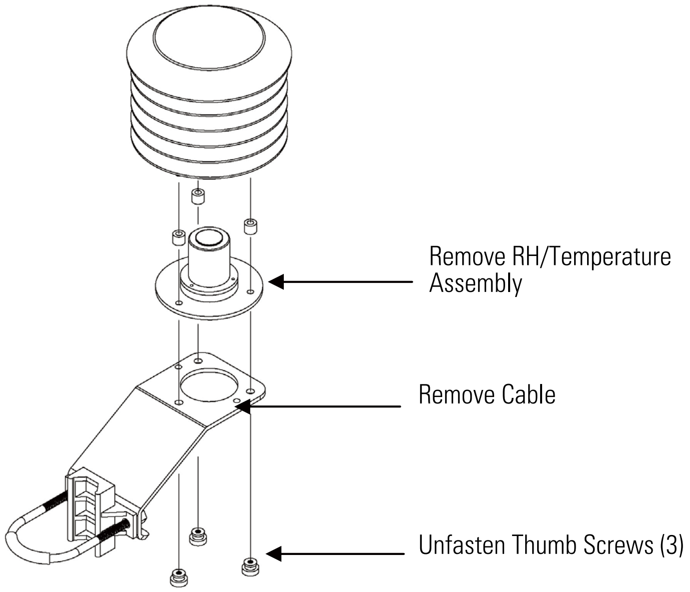


Figure 7–20. Replacing the Ambient RH/Temperature Assembly

Front Panel Board Replacement

Use the following procedure to replace the front panel board (Figure 7–21).

Equipment Required:

Front panel board

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Remove the three ribbon cables and the two-wire connector from the front panel board.

3. Pop the board off of the two top mounting studs and remove the board by lifting it up and off the slotted bottom support.

4. Replace the front panel board by following the previous steps in reverse.

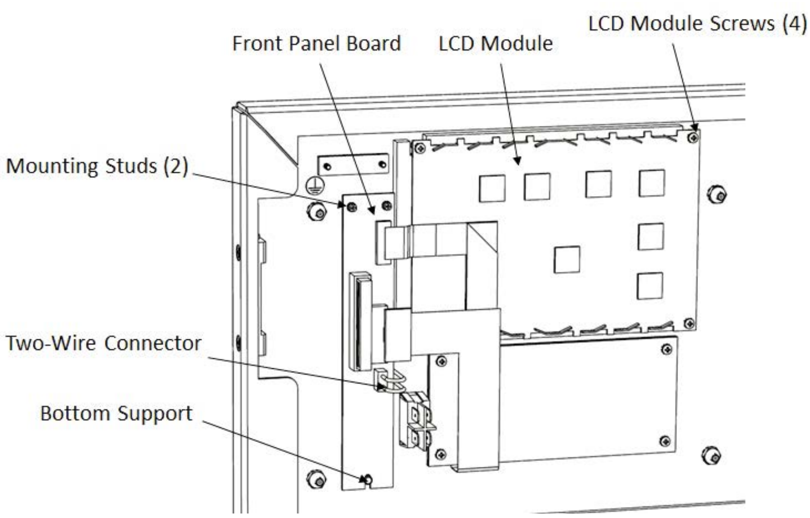


Figure 7–21. Replacing the Front Panel Board and the LCD Module

LCD Module Replacement

Use the following procedure to replace the LCD module (Figure 7–21).

Equipment Required:

LCD module

Philips screwdriver

CAUTION If the LCD panel breaks, do not let the liquid crystal contact your skin or clothes. If the liquid crystal contacts your skin or clothes, wash it off immediately using soap and water. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. A properly grounded antistatic wrist strap must be worn while handling any internal component. ▲

The LCD polarizing plate is very fragile, handle it carefully. ▲

Do not wipe the LCD polarizing plate with a dry cloth, as it may easily scratch the plate. ▲

Do not use alcohol, acetone, MEK or other Ketone based or aromatic solvents to clean the LCD module, but rather use a soft cloth moistened with a naphtha cleaning solvent. ▲

Do not place the LCD module near organic solvents or corrosive gases. ▲

Do not shake or jolt the LCD module. ▲

1. Turn the instrument OFF, unplug the power cord, and remove the cover.

2. Disconnect the ribbon cable and the two-wire connector from the front panel board.
3. Remove the four screws at the corners of the LCD module.
4. Slide the LCD module out towards the center of the instrument.
5. Replace the LCD module by following the previous steps in reverse.

Note The optimal contrast will change from one LCD screen to another. After replacing the LCD screen, the contrast may need to be reset. If the content on the screen is visible, select Instrument Controls > **Screen Contrast** and adjust the screen contrast. If the content on the screen is not visible, use the "set contrast 10" C-Link command to set screen constrast to mid range, then optimize the contrast. See the "C-Link Protocol Commands" appendix for more information on this command. ▲

Service Locations

For additional assistance, service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www. thermo.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 8
System Description

This chapter describes the function and location of the system components, provides an overview of the firmware structure, and includes a description of the system electronics and input/output connections and functions as follows:

- "Hardware" on page 8-1
- "Firmware" on page 8-5
- "Electronics" on page 8-6
- "I/O Components" on page 8-8

Hardware

Model 5028*i* hardware (Figure 8–1) includes:

- Measurement head
- Detector amplifier
- Cam photo interrupt board assembly
- Counter wheel interrupt board assembly
- Proportional valve
- 3-way valve
- Cam motor
- Tape motor
- Pressure board
- Battery board

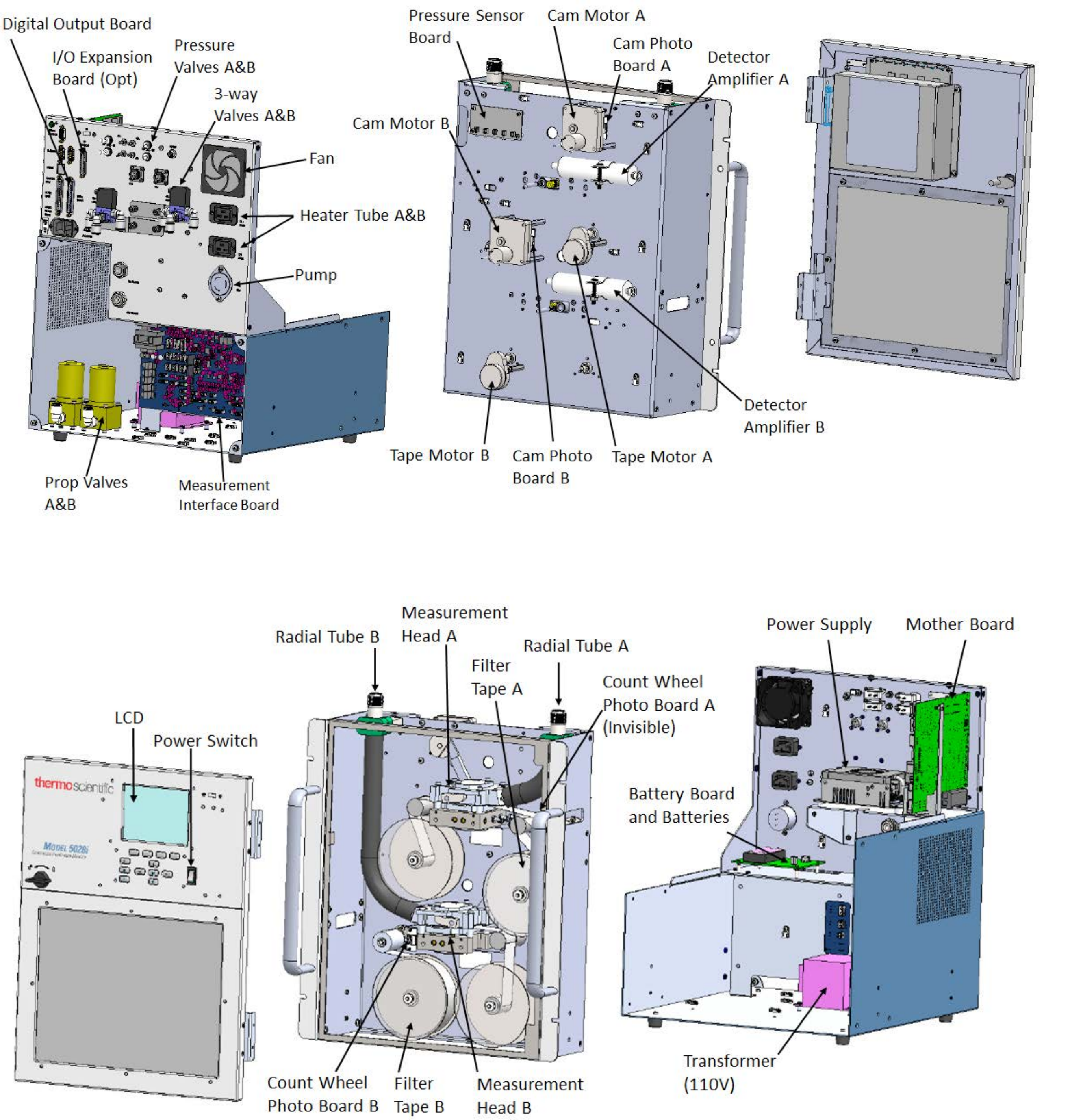


Figure 8–1. Hardware Components

Measurement Head

The measurement head uses a beta source and proportional alpha/beta detector to measure the attenuation of beta particles by sampled aerosol across a glass fiber filter and to discriminate against any naturally occurring beta interferences from the daughter nuclides of alpha decay products. The Model 5028*i* has two measurement heads, named as Channel A and Channel B.

Detector Amplifier

This cylindrical tube houses a printed circuit board, provides power to the proportional detector and amplifies the beta and alpha counts prior to being sent to the 5028*i* measurement interface board. The Model 5028*i* has two detector amplifiers, one is for Channel A, and another one is for Channel B, each detector amplifier can work independently.

Cam Photo Interrupt Board

This small printed circuit board includes a photo-interrupter to detect the closed position of the measurement head. This is connected to a motor assembly used to open and close the measurement head.

Counter Wheel Interrupt Board Assembly

This small printed circuit board is mounted onto a chopper wheel that measures the amount of filter tape advanced during a filter tape change.

Proportional Valve

The proportional valve is a proportional solenoid valve that is used as a means of flow control. In response to the measured flow across a subsonic orifice, the proportional valve will either partially open or close to make a flow adjustment in real-time. The Model 5028*i* has two proportional valves use to maintain the sample flow rate at its nominal value.

3-way Valve

The two 3-way valves on the real panel are controlled by the instrument firmware to make it power on or power off when automatic filter tape changes are controlled.

Cam Motor

This motor is used to drive the cam to rotate. By rotating the cam, the measurement head lever arm is raised and lowered for opening and closing the measurement head during a filter tape change.

Tape Motor

After the measurement head is opened, this motor is used to advance the filter tape a fixed amount prior to initiating another beta attenuation event on a fixed sample spot.

Pressure Board

This PCB assembly is mounted on the floor plate and has five pressure sensors attached. The pressure board is used to measure the barometric pressure, differential pressure across the orifice and vacuum under the filter tap for both channels. All tubing attached to the pressure board is numbered in case of the need to swap out this board.

Battery Board

This PCB assembly is mounted with two Li batteries to provide a backup power supply to proportional detectors, and can reduce the reliable data output time after power up/power interruption for a short time.

Firmware

The processor firmware tasks are organized into four areas:

- Instrument control
- Monitoring signals
- Measurement calculations
- Output communication

Instrument Control

Low-level embedded processors are used to control the various functions on the boards, such as analog and digital I/O. These processors are controlled over a serial interface with a single high-level processor that also controls the front-panel user interface. The low-level processors all run a common piece of firmware that is bundled with the high-level firmware and loaded on power-up if a different version is detected.

Each board has a specific address that is used to identify to the firmware what functions are supported on that board. This address is also used for the communications between the low-level processors and the high-level processor.

Every tenth of a second, the frequency counters, analog I/O, and digital I/O are read and written to by the low-level processors. The counters are accumulated over the past second and the analog inputs are averaged over that second. The high-level processor polls the low-level processors once per second to exchange the measurement and control data.

Monitoring Signals

Signals are gathered from the low-level processors once per second, and then processed by the high-level processor to produce the final measurement values. The one-second accumulated counts are accumulated and reported for the user-specified averaging time. If this averaging time is greater than ten seconds, the measurement is still reported every 10 seconds. The one-second average of the other analog inputs are reported directly (no additional signal conditioning is performed by the high-level processor).

Output Communication

The front panel display, serial and Ethernet data ports, and analog outputs are the means of communicating the results of the above calculations. The front panel display presents the concentrations simultaneously. The display is updated every 1-10 seconds, depending on the averaging time.

The analog output ranges are user selectable via firmware. The analog outputs are defaulted based on the measurement range. Negative concentrations can be represented as long as they are within -5% of full-scale. The zero and span values may be set by the user to any desired value.

Electronics

All electronics operate from a universal switching supply, which is capable of auto-sensing the input voltage and working over the all specified ranges.

External pumps and heaters all operate on 220 VAC. An optional transformer is required if operating on the 110VAC.

An on/off switch controls all power to the analyzer and is accessible on the front panel.

Motherboard

The motherboard contains the main processor, power supplies, and a sub-processor, and serves as the communication hub for the instrument. The motherboard receives operator inputs from the front panel function keys and/or over I/O connections on the rear panel. The motherboard sends commands to the other boards to control the functions of the instrument and to collect measurement and diagnostic information. The motherboard outputs instrument status and measurement data to the graphics display and to the rear-panel I/O. The motherboard also contains I/O circuitry and the associated connector to monitor external digital status lines and to output analog voltages that represent the measurement data. Connectors located on the motherboard include:

External connectors include:

- External Accessory
- RS-232/485 Communications (two connectors)
- Ethernet Communications
- I/O connector with Power Fail Relay, 16 Digital Inputs, and 6 Analog Voltage Outputs.

Internal connectors include:

- Function Key Panel and Display
- Measurement Interface Board
- I/O Expansion Board
- Digital Output Board
- AC Distribution

Measurement Interface Board

The measurement interface board serves as a central connection area for all measurement electronics in the instrument. It contains power supplies and interface circuitry for sensors and control devices in the measurement system. It sends status data to the motherboard and receives control signals from the motherboard.

Measurement Interface Board Connectors

Connectors located on the measurement interface board include:

- Data communication with the motherboard

- 24 V and 220 VAC power supply inputs
- Fan and solenoid outputs
- 220 VAC output and thermistor input from the sample heater
- Flow and pressure sensor inputs
- Proportional valve output
- Optical pickup input
- Pre-amp board
- Ambient temperature/RTD and RH
- Flow RTDs

Flow Sensor System

The flow sensor system consists of a subsonic orifice inside the primary measurement head, a differential pressure and vacuum sensors, and a flow temperature RTD. The flow system output is produced by measuring the pressure difference across a precision orifice. This unit is used for measuring the flow of sample gas in the measurement system.

Pressure Sensor Assembly

The pressure sensor assembly consists of a board containing five pressure transducers with tube connections. The pressure transducer output is produced by measuring the pressure difference between the sample gas pressure and ambient air pressure.

Detector Amplifier Assembly

The detector amplifier assembly amplifies the signal from the proportional detector that receives beta particle emissions from the C-14 source through the sample and filter tape. The output of the detector amplifier is fed to the measurement interface board. A coaxial cable from the detector amplifier supplies power and grounding to the detector.

Digital Output Board

The digital output board connects to the motherboard and provides solenoid driver outputs and relay contact outputs to a connector located on the rear panel of the instrument. Ten relay contacts, normally open (with power off), are provided, which are electrically isolated from each other. Eight solenoid driver outputs (open collector) are provided along with a corresponding +24 VDC supply pin on the connector.

I/O Expansion Board (Optional)

The I/O expansion board connects to the motherboard and adds the capability to input external analog voltage signals and to output analog currents via a connector located on the rear panel of the instrument. It contains local power supplies, a DC/DC isolator supply, a sub-processor and analog circuits. Eight analog voltage inputs are provided with an input voltage range of 0V to10 VDC. Six current outputs are provided with a normal operating range of 0 to 20 mA.

Front Panel Connector Board

The front panel connector board interfaces between the motherboard and the function key panel and graphics display. It serves as a central location to tie the three connectors required for the function key panel, the graphics display control lines, and the graphics display backlight to a single ribbon cable extending back to the motherboard. This board also includes signal buffers for the graphics display control signals and a high voltage power supply for the graphics display backlight.

I/O Components

External I/O is driven from a generic bus that is capable of controlling the following devices:

- Analog output (voltage and current)
- Analog input (voltage)
- Digital output (TTL levels)
- Digital input (TTL levels)

Note The instrument has spare solenoid valve drivers and I/O support for future expansion. ▲

Analog Voltage Outputs

The instrument provides six analog voltage outputs. Each may be firmware configured for any one of the following ranges, while maintaining a minimum resolution of 12 bits:

- 0-100 mV
- 0-1 V
- 0-5 V
- 0-10 V

The user can calibrate each analog output zero and span point through the firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in the firmware, if required.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The voltage outputs are independent of the current outputs.

Analog Current Outputs (Optional)

The optional I/O expansion board includes six isolated current outputs. These are firmware configured for any one of the following ranges, while maintaining a minimum resolution of 11 bits:

- 0-20 mA
- 4-20 mA

The user can calibrate each analog output zero and span point through the firmware. At least 5% of full-scale over and under range are also supported, but may be overridden in the firmware, if required.

The analog outputs may be assigned to any measurement or diagnostic channel with a user-defined range in the units of the selected parameter. The current outputs are independent of the voltage outputs. The current outputs are isolated from the instrument power and ground, but they share a common return line (Isolated GND).

Analog Voltage Inputs (Optional)

The optional I/O expansion board includes eight analog voltage inputs. These inputs are used to gather measurement data from third-party devices such as meteorological equipment. The user may assign a label, unit, and a conversion table (2 to 10 points). Each point in the conversion table consists of an analog input voltage value (0-10.5 V) and a corresponding user-defined reading value. Only two points are necessary for linear inputs, however, a larger number of points may be used to approximate non-linear inputs. All voltage inputs have a resolution of 12 bits over the range of 0 to 10 volts.

Digital Relay Outputs

The instrument includes one power fail relay on the motherboard and ten digital output relays on the digital output board. These are reed relays rated for at least 500 mA @ 200 VDC.

The power fail relay is Form C (both normally opened and normally closed contacts). All other relays are Form A (normally opened contacts) and are used to provide alarm status and mode information from the analyzer, as well as remote control to other devices, such as for controlling valves during calibration. The user may select what information is sent out from each relay and whether the active state is opened or closed.

Digital Inputs

Sixteen digital inputs are available, which may be programmed to signal instrument modes and special conditions including:

- Filter tape change
- Turn pump off
- Turn pump on
- Analog outputs to zero

- Analog outputs to full-scale

The actual use of these inputs will vary based on analyzer configuration.

The digital inputs are TTL level compatible and are pulled up within the analyzer. The active state can be user defined in firmware.

Serial Ports

Two serial ports allow daisy chaining so that multiple analyzers may be linked using one PC serial port.

The standard bi-directional serial interface can be configured for either RS-232 or RS-485. The serial baud rate is user selectable in the firmware for standard speeds from 1200 to 115200 baud. The user can also set the data bits, parity, and stop bits. The following protocols are supported:

- C-Link
- MODBUS Slave
- Gesytec (Bayern-Hessen)
- Streaming Data
- ESM

The Streaming Data protocol transmits user-selected measurement data via the serial port in real-time for capture by a serial printer, datalogger, or PC.

RS-232 Connection

A null modem (crossed) cable is required when connecting the analyzer to an IBM-compatible PC. However, a straight cable (one to one) may be required when connecting the analyzer to other remote devices. As a general rule, when the connector of the host remote device is female, a straight cable is required and when the connector is male, a null modem cable is required.

Data Format:

1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 BAUD

7 or 8 data bits

1 or 2 stop bits

No, odd, or even parity

All responses are terminated with a carriage return (hex 0D)

Refer to Table 8–1 for the DB9 connector pin configuration.

Table 8–1. RS-232 DB9 Connector Pin Configuration

DB9 Pin	Function
2	RX
3	TX
7	RTS
8	CTS
5	Ground

RS-485 Connection

The instrument uses a four wire RS-485 configuration with automatic flow control (SD). Refer to Table 8–2 for the DB9 connector pin configuration.

Table 8–2. RS-485 DB9 Connector Pin Configuration

DB9 Pin	Function
2	+ receive
8	- receive
7	+ transmit
3	- transmit
5	ground

Ethernet Connection

An RJ45 connector is used for the 10Mbs Ethernet connection supporting TCP/IP communications via standard IPV4 addressing. The IP address may be configured for static addressing or dynamic addressing (set using a DHCP server).

Any serial port protocols may be accessed over Ethernet in addition to the serial port. Up to three simultaneous connections are allowed per protocol.

External Accessory Connector

The external accessory connector is not used in the Model 5014*i* analyzer.

This port is used in other models to communicate with smart external devices that may be mounted hundreds of feet from the analyzer using an RS-485 electrical interface.

Chapter 9
Optional Equipment

The Model 5028*i* is available with the following options:

Inlet Assemblies

The Model 5028*i* can be used for different applications. Using different inlet configurations (PM_{10}, $PM_{2.5}$, PM_1 Inlets), several particle size fractions can be monitored. The main application is the measurement of PM_{10} and $PM_{2.5}$ for ambient air quality monitoring and health effect studies.

Sampling Tube Extensions

Often the most compatible way to install the Model 5028*i* at air quality monitoring sites is to collocate the inlet at the same height as other similar-use inlets. The "Installation" chapter discusses specific siting criteria. In addition to using the optional inlets, extending the sample downtube length is necessary using a rigid sample tube.

I/O Expansion Board Assembly

The I/O expansion board provides six analog current output channels (0-20 mA or 4-20 mA) and eight analog voltage inputs (0-10 V). The DB25 connector on the rear panel provides the interface for these inputs and outputs.

25 Pin Terminal Board Assembly

The 25-pin terminal board assembly is included with the optional I/O expansion board. Refer to "Terminal Board PCB Assemblies" in the "Installation" chapter for information on attaching the cable to the connector board. For associated part numbers, refer to the "Servicing" chapter.

Terminal Block and Cable Kits

The optional terminal block and cable kits provide a convenient way to connect devices to the instrument. These kits break out the signals on the rear panel connector to individual numbered terminals.

Two types of terminal block and cable kits are available. One kit is for the DB37 connectors and can be used for either the analog output connector or the relay output connector. The other kit is for the DB25 connector and can be used for the optional I/O expansion board. For associated part numbers, refer to "External Device Connection Components" on page 7-7.

Each kit consists of:

- one six-foot cable
- one terminal block
- one snap track

Note Supporting all of the connections on units with the optional I/O expansion board requires:

- two DB37 kits
- one DB25 kit

Cables

Table 9–1 identifies the optional individual cables that are available for the instrument and Table 9–2 provides the cable color codes. For associated part numbers, refer to "External Device Connection Components" on page 7-7.

Note Table 9–2 provides the color coding for both 25-pin cables and 37-pin cables. Color codes for pins 1–25 are for 25-pin cables; color codes for pins 1–37 are for 37-pin cables. ▲

Table 9–1. Cable Options

Description	Cable Length
DB37M to open end	Six feet
DB37F to open end	Six feet
DB25M to open end	Six feet
RS-232	Six feet

Table 9–2. Color Codes for 25-Pin and 37-Pin Cables

Pin	Color	Pin	Color
1	BLACK	20	RED/BLACK
2	BROWN	21	ORANGE/BLACK
3	RED	22	YELLOW/BLACK
4	ORANGE	23	GREEN/BLACK

Pin	Color	Pin	Color
5	YELLOW	24	GRAY/BLACK
6	GREEN	25	PINK/BLACK
7	BLUE	End color codes for 25-pin cables continue for 37-pin cables.	
8	VIOLET	26	PINK/GREEN
9	GRAY	27	PINK/RED
19	WHITE	28	PINK/VIOLET
11	PINK	29	LIGHT BLUE
12	LIGHT GREEN	30	LIGHT BLUE/BROWN
13	BLACK/WHITE	31	LIGHT BLUE/RED
14	BROWN/WHITE	32	LIGHT BLUE/VIOLET
15	RED/WHITE	33	LIGHT BLUE/BLACK
16	ORANGE/WHITE	34	GRAY/GREEN
17	GREEN/WHITE	35	GRAY/RED
18	BLUE/WHITE	36	GRAY/VIOLET
19	VIOLET/WHITE	37	LIGHT GREEN/BLACK

Mounting Options

The analyzer can be installed in the configuration described Figure 9–3.

Table 9–3. Mounting Options

Mounting Type	Description
Bench	Positioned on bench
Retrofit rack (top position)	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles. This configuration is intended for direct replacement of a C-series instrument in an existing rack. The rail mounting location is lower on the case and the front mounting screw slots have non-standard EIA locations.

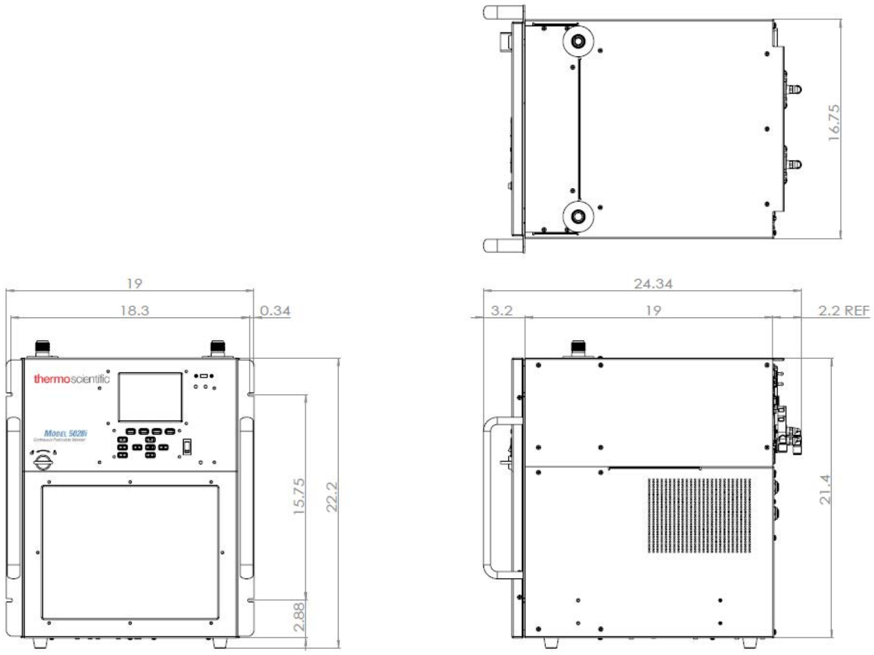


Figure 9–1. Bench Mounting

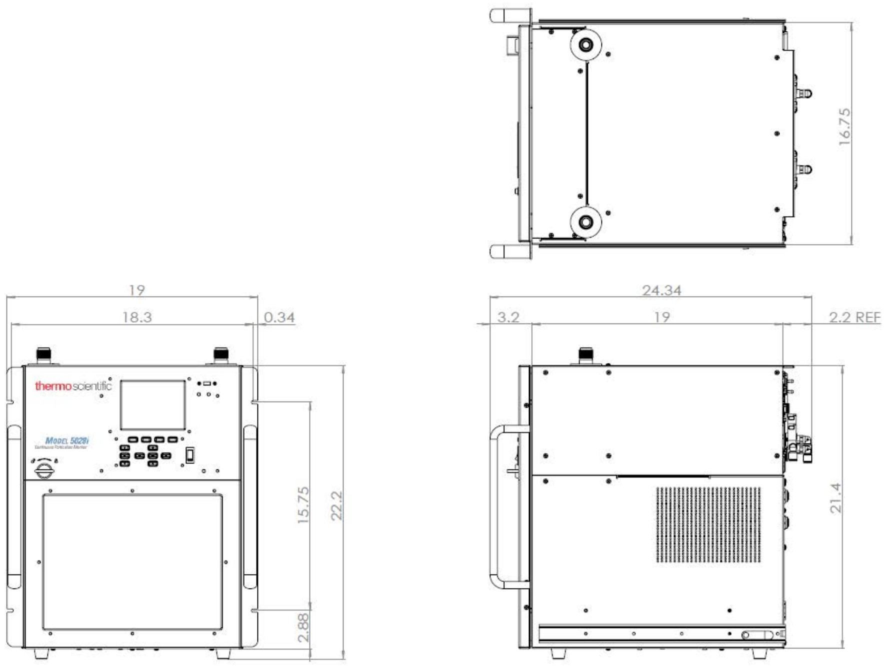


Figure 9–2. Rack Mounting

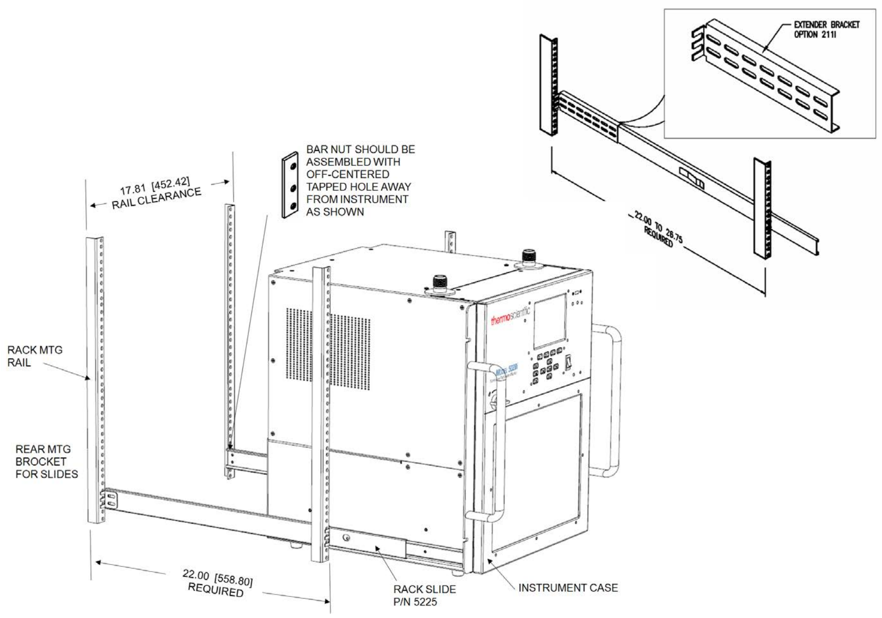


Figure 9–3. Rack Mount Option Assembly

Roof Flange Assembly

An optional roof flange assembly can be used with flat roof applications, as shown in Figure 9–4. This roof flange assembly uses 3” PVC tubing, fittings and roof flange with gasketing. The installer must assure a water tight installation when using a flange of this design. A 2-1/2” circular hole should be drilled through the roofline of the the enclosure, or building, if it has a flat roof. The roof surface should be clean and swept of all debris. The flange should be centered over the hole that has been drilled. A generous bead of RTV or silicone sealent should be applied to the circumfernce of the ponts shown in Figure 9–4.

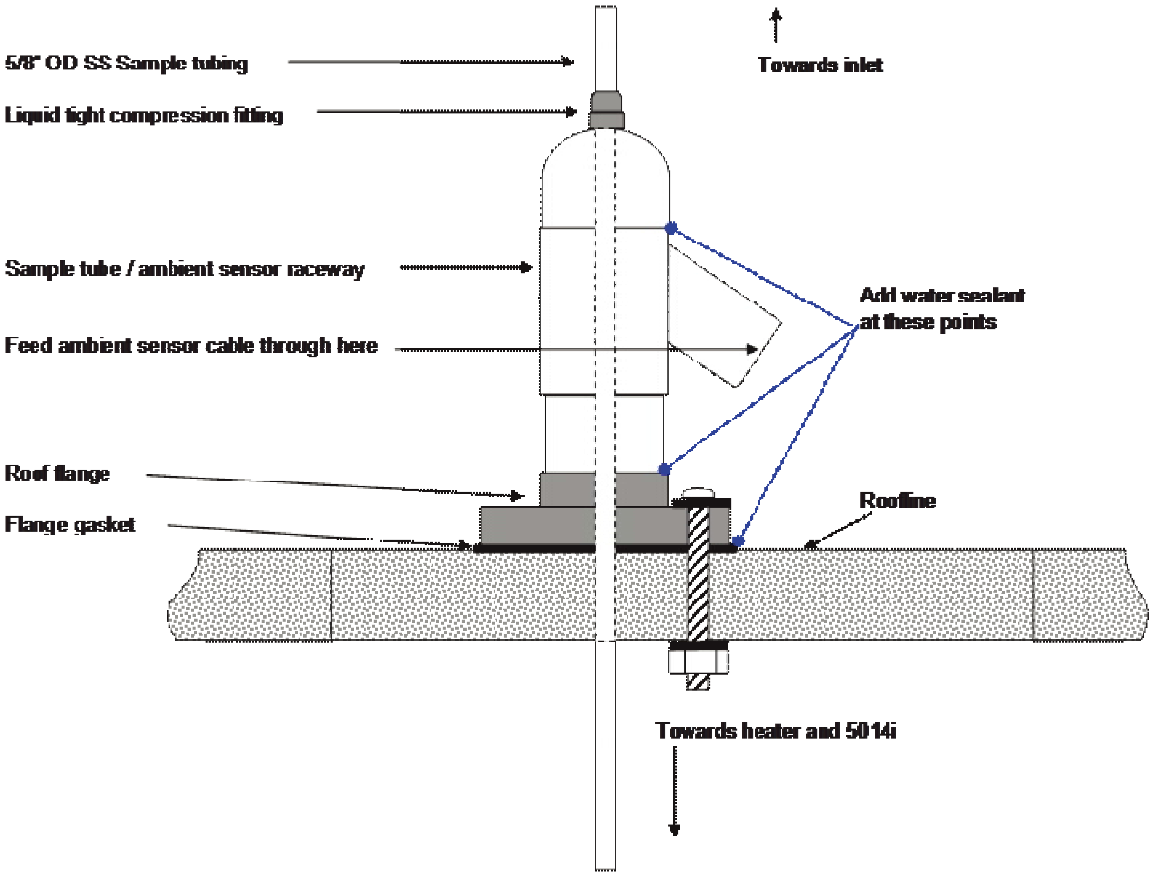


Figure 9–4. Roof Flange Assembly

The flange design also has four holes that can be used to secure the flange to the roof surface by the use of carriage bolts, washers and nuts. The length of the carriage bolts depends on the thickness of the roofline. Figure 9–5 shows a picture of the roof flange that is used with this assembly.

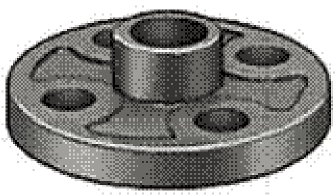


Figure 9–5. Securing the Roof Flange

Appendix A
Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the

Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

Appendix B
C-Link Protocol Commands

This appendix provides a description of the C-Link protocol commands that can be used to remotely control a Model 5028*i* analyzer using a host device such as a PC or a datalogger. C-Link protocol may be used over RS-232, RS-485, or Ethernet. C-Link functions can be accessed over Ethernet using TCP port 9880.

Streaming data is sent out the serial port or the Ethernet port on a user-defined periodic basis. Streaming data over Ethernet is only generated when a connection is made on TCP port 9881.

Up to three simultaneous connections per protocol may be made over Ethernet.

For details, see the following topics:

Instrument Identification Number

Each command sent to the analyzer over the serial port must begin with the American Standard Code for Information Interchange (ASCII) symbol or byte value equivalent to the instrument's identification number plus 128. For example, if the instrument ID is set to 14, then each command must begin with the ACSII character code 142 decimal.

The analyzer ignores any command that does not begin with its instrument identification number. If the instrument ID is set to 0, then this byte is not required. For more information on changing Instrument ID, see Chapter 3, "Operation".

Commands

The analyzer must be in the remote mode and service mode not active in order to change instrument parameters remotely. However, the command "set mode remote" can be sent to the analyzer to put it in the remote mode. Report commands (commands that don't begin with "set") can be issued either in the remote or local mode, regardless of the service mode setting. For information on changing modes, see Chapter 3, "Operation".

The commands are not case sensitive. Each command must begin with the proper instrument identification number (ASCII) character. The command in the following example begins with the ASCII character code 142 decimal, which directs the command to the Model 5028*i*, and is terminated by a carriage return "CR" (ASCII character code 13 decimal).

<ASCII 142>	T	I	M	E	<CR>

Many of the commands have two forms. One form reads parameter from the instrument's memory, and the other writes, or updates, a parameter. The syntax for a write command adds the word "set" in front of the command and provides an argument. Command responses are generally echoed with a data element appended.

Note If the Service Mode is active, C-Link "set" commands are not allowed. This is to prevent parameters from being changed remotely while the unit is being serviced locally. ▲

If an incorrect command is sent, an error message is generated. The list of error responses is shown in Table B–1. The following example sends the incorrect command "set unit mg/m3" instead of the correct command "set conc unit mg/m3."

```
Send:        set unit mg/m3
Receive:     set unit mg/m3 bad cmd
```

Flow B settings please refer to Flow A as following description.

```
Send:        avg24 time a
Receive:     avg24 time a 18:30

Send:        avg24 time b
Receive:     avg24 time b 18:30
```

Table B–1. Error Response Messages

Command Response	Description
bad cmd	Command is not recognized
too high	Supplied value is higher than the upper limit
too low	Supplied value is lower than the lower limit
invalid string	Supplied string invalid (typically because a letter was detected when the value should be numeric)
data not valid	Supplied value is not acceptable for entered command
can't, wrong settings	Command not allowed for current measurement mode
can't, mode is service	Command not allowed while instrument is in service mode
feature not enabled	I/O expansion board is not detected
flags no alarm active	No measurement alarms are active

The "save" and "set save params" commands (duplicated for backward compatibility) store parameters in FLASH memory. It is important that this command be sent each time instrument parameters are changed. If changes are not saved, they will be lost in the event of a power failure.

Commands List

Table B–2 lists the 5028*i* C-Link protocol commands. The interface will respond to the command strings outlined below.

Table B–2. C-Link Protocol Commands

Command	Description	Page
addr dns	Reports/sets domain name server address for Ethernet port	B-48
addr gw	Reports/sets default gateway address for Ethernet port	B-49
addr ip	Reports/sets IP address for Ethernet port	B-49
addr nm	Reports/sets netmask address for Ethernet port	B-49
addr ntp	Reports/sets IP address for network time protocol server	B-50
alarm alpha count max a/b	Reports/sets alpha count alarm maximum value	B-11
alarm alpha count min a/b	Reports/sets alpha count alarm minimum value	B-11
alarm amb rh max	Reports/sets ambient relative humidity alarm maximum value	B-12
alarm amb rh min	Reports/sets ambient relative humidity alarm minimum value	B-12
alarm amb temp max	Reports/sets ambient temperature alarm maximum value	B-12
alarm amb temp min	Reports/sets ambient temperature alarm minimum value	B-12

Command	Description	Page
alarm baro pres max	Reports/sets barometric pressure alarm maximum value	B-13
alarm baro pres min	Reports/sets barometric pressure alarm minimum value	B-13
alarm bench status	Reports the bench status	B-13
alarm beta count max	Reports/sets beta count alarm maximum value	B-13
alarm beta count min	Reports/sets beta count alarm minimum value	B-13
alarm board temp max	Reports/sets board temperature alarm maximum value	B-14
alarm board temp min	Reports/sets board temperature alarm minimum value	B-14
alarm conc avg pm max a/b	Reports/sets average PM concentration alarm maximum value	B-14
alarm conc avg pm min a/b	Reports/sets average PM concentration alarm minimum value	B-14
alarm conc inst pm max a/b	Reports/sets instant PM concentration alarm maximum value	B-15
alarm conc inst pm min a/b	Reports/sets instant PM concentration alarm minimum value	B-15
alarm filter tape status a/b	Reports the filter tape status	B-15
alarm flow max a/b	Reports/sets flow alarm maximum value	B-15
alarm flow min a/b	Reports/sets flow alarm minimum value	B-15
alarm flow pres max a/b	Reports/sets flow pressure alarm maximum value	B-16
alarm flow pres min a/b	Reports/sets flow pressure alarm minimum value	B-16
alarm flow temp max a/b	Reports/sets flow temperature alarm maximum value	B-16
alarm flow temp min a/b	Reports/sets flow temperature alarm minimum value	B-16
alarm ib status	Reports the interface board status	B-17
alarm io status	Reports the I/O expansion board status	B-17
alarm mb status	Reports the motherboard status	B-17
alarm sample rh max a/b	Reports/sets sample relative humidity alarm maximum value	B-17
alarm sample rh min a/b	Reports/sets sample relative humidity alarm minimum value	B-17

Command	Description	Page
alarm status det a/b	Reports the detector status	B-18
alarm tape counter max	Reports/sets tape counter alarm maximum value	B-18
alarm vac pres max a/b	Reports/sets vacuum pressure alarm maximum value	B-18
alarm vac pres min a/b	Reports/sets vacuum pressure alarm minimum value	B-18
allow mode cmd	Reports/sets the current "set" allow mode command	B-50
alpha eff a/b	Reports/sets the current value of alpha efficiency for the detector	B-30
alpha th a/b	Reports/sets the current value of alpha threshold for the detector	B-30
amb rh	Reports the ambient relative humidity	B-19
amb rh offset	Reports/sets the current ambient relative humidity offset	B-30
amb temp	Reports the current ambient temperature	B-19
amb temp offset	Reports/sets the current ambient temperature offset	B-31
analog iout range	Reports/sets analog current output range per channel	B-55
analog vin	Retrieves analog voltage input data per channel	B-55
analog vout range	Reports/sets analog voltage output range per channel	B-56
avg24 time a/b	Reports/sets 24-hour averaging time to start averaging the concentration	B-10
baro mass coef a/b	Reports/sets the current barometric mass coefficient	B-31
baro pres	Reports the current barometric pressure	B-19
baro span	Reports/sets the current barometric pressure span	B-32
baud	Reports/sets current baud rate	B-51
beta th a/b	Reports/sets the current reference beta threshold for the detector	B-32
bkg pm a/b	Reports/sets current PM background	B-32
board temp	Reports the current board temperature	B-19
cal baro pres span	Automatically calculates the span coefficient	B-33
cal flow pres span a/b	Automatically sets the flow pressure span	B-33
cal flow span a/b	Automatically sets the flow span	B-33
cal vac flow offset a/b	Automatically sets the vacuum/flow offset	B-34

Command	Description	Page
cal vac pres span a/b	Automatically sets the vacuum pressure span	B-33
clr lrecs	Clears away only lrecs that have been saved	B-23
clr records	Clears away all logging records that have been saved	B-23
clr srecs	Clears away only srecs that have been saved	B-23
coef pm a/b	Reports/sets current PM coefficient	B-34
conc unit	Reports/sets current concentration units	B-40
contrast	Reports/sets current screen contrast	B-46
copy lrec to sp	Sets/copies current lrec selection into the scratch pad	B-23
copy sp to lrec	Sets/copies current selections in scratch pad into lrec list	B-23
copy sp to srec	Sets/copies current selections in scratch pad into srec list	B-23
copy sp to stream	Sets/copies current selections in scratch pad into stream list	B-23
copy srec to sp	Sets/copies current srec selection into the scratch pad	B-23
copy stream to sp	Sets/copies current streaming data selection into the scratch pad	B-23
crn a/b	Reports the current radon concentration	B-19
custom	Reports/sets defined custom range concentration	B-40
data treatment lrec	Reports/sets data treatment for concentration values in lrecs	B-24
data treatment srec	Reports/sets data treatment for concentration values in srecs	B-24
date	Reports/sets current date	B-47
default params	Sets parameters to default values	B-47
det	Reports/sets the status of the detector board	B-47
det status a/b	Reports the current mass for the detector	B-19
dhcp	Reports/sets state of use of Dynamic Host Configuration Protocol (DHCP)	B-51
diag volt det a/b	Reports diagnostic voltage levels on the detector board	B-20
diag volt iob	Reports diagnostic voltage levels on the I/O expansion board	B-20
diag volt mb	Reports diagnostic voltage levels on the motherboard	B-20
diag volt mib	Reports diagnostic voltage levels on the measurement interface board	B-20
diag volt neph	Reports diagnostic voltage levels on the nephelometer interface board	B-20
dig in	Reports status of the digital inputs	B-56
din	Reports/sets digital input channel and active state	B-56
do (down)	Simulates pressing down pushbutton	B-38

Command	Description	Page
dout	Reports/sets digital output channel and active state	B-57
dtoa	Reports outputs of the digital to analog converters per channel	B-57
en (enter)	Simulates pressing enter pushbutton	B-38
er	Returns a brief description of the main operating conditions in the format specified in the commands	B-24
erec	Returns a snapshot of the main operating conditions (measurements and status) in the specified format	B-24
erec format	Reports/sets erec format	B-26
erec layout	Reports current layout of erec data	B-27
filter period	Reports/sets the number of hours to be added to filter next time for the filter tape change	B-40
filter tape a/b move	Sets filter tape movement	B-41
filter time	Reports/sets the next date and time of the filter tape change	B-41
flags	Reports current active measurement status flags in HEX	B-10
flow a/b	Reports the current sample flow	B-20
flow pres a/b	Reports the current flow pressure	B-21
flow pres span a/b	Reports/sets the flow pressure span	B-34
flow pres offset	Reports the flow pressure offset	B-35
flow span a/b	Reports/sets the current flow span	B-35
flow target a/b	Reports/sets the current flow	B-41
flow temp a/b	Reports the current flow temperature	B-21
flow temp offset a/b	Reports/sets offset for flow temperature	B-35
format	Reports/sets current reply termination format	B-52
he (help)	Simulates pressing help pushbutton	B-38
high volt a/b	Reports/sets the current high voltage for the detector	B-36
host name	Reports/sets host name string	B-52
ht control a/b	Reports/sets the current status of the heater	B-42
instr name	Reports instrument name	B-53
instrument id	Reports/sets instrument id	B-53
io bd	Reports/sets the presense of the I/O expansion board	B-21
isc (iscreen)	Retrieves framebuffer data used for the display	B-38
layout ack	Reports/disables stale layout/layout changed indicator (‘*’)	B-53
le (left)	Simulates pressing left pushbutton	B-38
list din	Lists current selection for digital inputs	B-58
list dout	Lists current selection for digital outputs	B-58

Command	Description	Page
list lrec	Lists current selection lrec logging data	B-25
list sp	Lists current selection in the scratchpad list	B-25
list srec	Lists current selection srec logging data	B-25
list stream	Lists current selection streaming data output	B-25
list var aout	Reports list of analog output, index numbers, and variables	B-58
list var din	Reports list of digital input, index numbers, and variables	B-58
list var dout	Reports list of digital output, index numbers, and variables	B-58
list var log	Reports a list of datalogging index numbers and variables	B-58
lr	Reports the last lrec stored	B-25
lrec	Reports maximum number of lrecs	B-25
lrec format	Reports/sets output format for lrecs (ASCII or binary)	B-26
lrec layout	Reports current layout of lrec data	B-27
lrec mem size	Reports maximum number of lrecs that can be stored	B-27
lrec per	Reports/sets lrec logging period	B-27
malloc lrec	Reports/sets memory allocation for lrecs	B-27
malloc srec	Reports/sets memory allocation for srecs	B-27
mass a/b	Reports the presence of mass	B-21
mass coef a/b	Reports/sets the current mass coefficient	B-36
mass limit	Reports/sets the current filter mass limit	B-42
me (menu)	Simulates pressing menu pushbutton	B-38
no of lrec	Reports number of lrecs stored in memory	B-28
no of srec	Reports number of srecs stored in memory	B-28
pm a/b	Reports the measured PM concentration	B-11
pm 24avg a/b	Reports the 24-hour average PM concentration	B-11
power up mode	Reports/sets the power up mode as local or remote	B-54
pres comp	Reports/sets pressure compensation to actual or standard	B-43
pres std a/b	Reports/sets the standard pressure	B-43
program no	Reports analyzer program number	B-54
pump	Reports/sets pump on or off	B-47
purge mode a/b	Set purge mode on	B-22
push	Simulates pressing a key on the front panel	B-38
range a/b	Reports/sets current PM range	B-43
relay	Sets relay logic status for the designated relay(s)	B-59
relay stat	Reports relay logic status for all relay(s)	B-59
reset tape counter	Resets the tape count to zero	B-21

Command	Description	Page
rh th a/b	Reports/sets the current relative humidity threshold for the detector	B-44
ri (right)	Simulates pressing right pushbutton	B-38
ru (run)	Simulates pressing run pushbutton	B-38
sample rh a/b	Reports the sample relative humidity	B-22
save	Stores parameters in FLASH	B-48
save params	Stores parameters in FLASH	B-48
sc (screen)	C-series legacy command that reports a generic response (Use iscreen instead)	B-39
sp field	Reports/sets item number and name in scratch pad list	B-28
sr	Reports the last srec stored	B-25
srec	Reports maximum number of srecs	B-25
srec format	Reports/sets output format for srecs (ASCII or binary)	B-26
srec layout	Reports current layout of srec data	B-27
srec mem size	Reports maximum number of srecs that can be stored	B-27
srec per	Reports/sets srec logging period	B-27
stream per	Reports/sets current time interval for streaming data	B-29
stream time	Reports/sets a time stamp to streaming data or not	B-29
tape counter	Reports the number of counts corresponding to the filter tape movement	B-22
tape to ncal ratio a/b	Reports/sets tape/zero ratio	B-38
temp comp	Reports/sets temperature compensation to actual or standard	B-45
temp std a/b	Reports/sets the standard temperature	B-45
temp th a/b	Reports/sets the temperature threshold for the detector	B-45
thermal mass coef a/b	Reports/sets the current thermal mass coefficient	B-36
time	Reports/sets current time (24-hour format)	B-48
tz	Reports/sets the timezone string for the NTP server	B-54
up	Simulates pressing up pushbutton	B-38
vac mass coef a/b	Reports/sets the current vacuum mass coefficient	B-37
vac pres a/b	Reports the current vacuum pressure	B-22
vac pres offset a/b	Reports the vacuum pressure offset	B-22
vac pres span a/b	Reports/sets the vacuum pressure span	B-37
vf pres cal def	Sets vacuum and flow pressure calibration defaults	B-38

Measurements

avg24 time a/b

This command reports the 24 hour averaging time in hours and minutes. The following example shows that the averaging time is set to 18:30.

```
Send:        avg24 time a
Receive:     avg24 time a 18:30

Send:        avg24 time b
Receive:     avg24 time b 18:30
```

set avg 24 time a/b *hh:mm*

hh = hours (01 to 23)

mm = minutes (01 to 59)

This command sets the 24 hour averaging time to start averaging the concentration from hh:mm until next 24 hours. It is then set to next 24 hours automatically. The following example sets the 24 hour averaging time to 17:50.

```
Send:        set avg24 time a 17:50
Receive:     set avg24 time a 17:50 ok

Send:        set avg24 time b 17:50
Receive:     set avg24 time b 17:50 ok
```

flags

This reports 8 hexadecimal digits (or flags) that represent the status of the mode, pressure and temperature compensation status, concentration units, concentration modes and alarms. To decode the flags, each hexadecimal digit is converted to binary as shown in the Figure B–1. It is the binary digits that define the status of each parameter.

```
Send:        flags
Receive:     flags 00000000
```

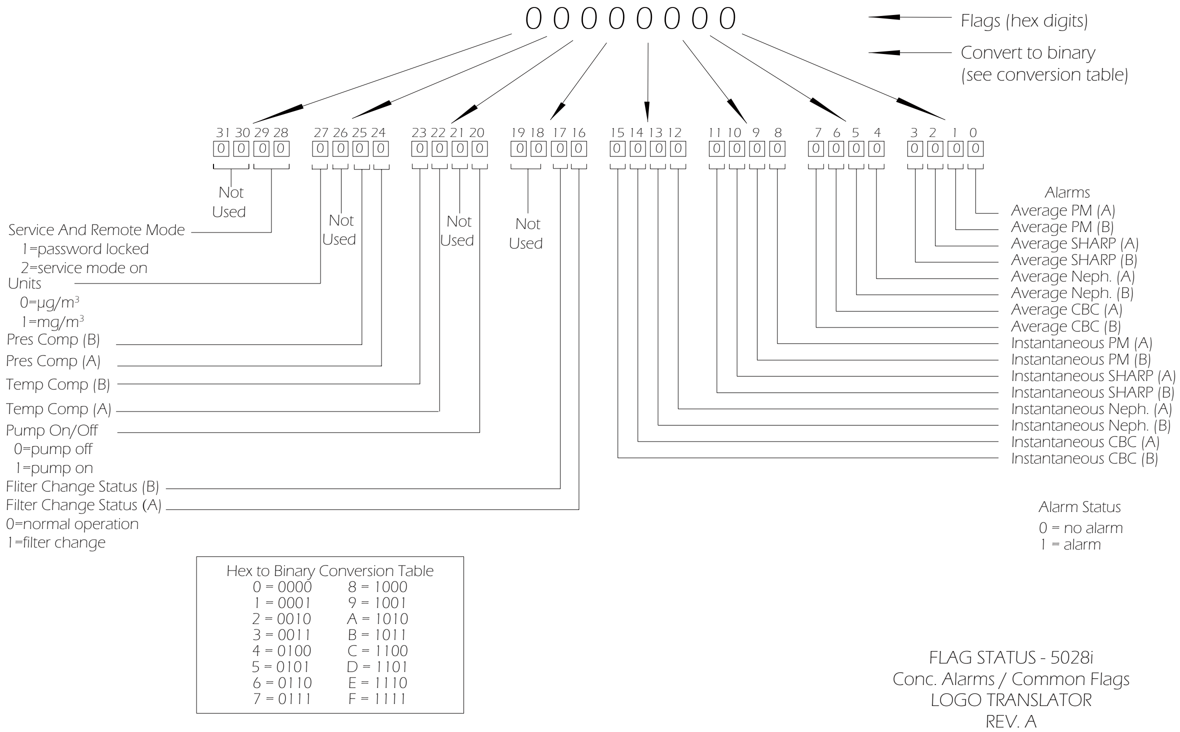


Figure B–1. Flags Field

---

pm a/b

This command reports the measured PM concentration. The following example shows that the PM concentration is 14.1 mg/m^3.

```
Send:          pm a
Receive:       pm a 1.410E+01 mg/m3

Send:          pm b
Receive:       pm b 1.410E+01 mg/m3
```

---

pm 24avg a/b

This command reports the 24 hour averaging PM concentration value, where value is a floating-point number representing PM concentration in the currently selected units. The following example reports the 24 hour PM concentration value.

```
Send:          pm 24avg a
Receive:       pm 24avg a 10.000E+00 ug/m3

Send:          pm 24avg b
Receive:       pm 24avg b 10.000E+00 ug/m3
```

Alarms

---

alarm alpha count min a/b
alarm alpha count max a/b

These commands report the current alpha count alarm minimum and maximum value settings. The following example reports that the alpha count alarm minimum value is 200.

```
Send:        alarm alpha count min a
Receive:     alarm alpha count min a 200

Send:        alarm alpha count min b
Receive:     alarm alpha count min b 200
```

set alarm alpha count min a/b *value*
set alarm alpha count max a/b *value*
These commands set the alpha count alarm minimum and maximum values to *x*, where *x* is an integer representing alpha count limits. The following example sets the alpha count alarm maximum value to 500.

```
Send:        set alarm alpha count max a 500
Receive:     set alarm alpha count max a 500 ok

Send:        set alarm alpha count max b 500
Receive:     set alarm alpha count max b 500 ok
```

alarm amb rh min
alarm amb rh max
These commands report the current ambient relative humidity alarm minimum and maximum value settings. The following example reports the ambient relative humidity alarm minimum value is 35.0%.

```
Send:        alarm amb rh min
Receive:     alarm amb rh min 35.0%
```

set alarm amb rh min *value*
set alarm amb rh max *value*
These commands set the ambient relative humidity alarm minimum and maximum values to *value*, where *value* is a floating-point number representing ambient relative humidity alarm limits in percent. The following example sets the ambient relative humidity alarm maximum value to 55%.

```
Send:        set alarm amb rh max 55%
Receive:     set alarm amb rh max 55% ok
```

alarm amb temp min
alarm amb temp max
These commands report the current ambient temperature alarm minimum and maximum value settings. The following example reports that the ambient temperature alarm minimum value is 4.0 °C.

```
Send:        alarm amb temp min
Receive:     alarm amb temp min 4.0 degC
```

set alarm amb temp min *value*
set alarm amb temp max *value*
These commands set the ambient temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number

representing ambient temperature alarm limits in °C. The following example sets the ambient temperature alarm maximum value to 38 °C.

```
Send:         set alarm amb temp max 38.0
Receive:      set alarm amb temp max 38.0 ok
```

---

alarm baro pres min
alarm baro pres max
These commands report the current barometric pressure alarm minimum and maximum value settings. The following example reports that the barometric pressure alarm minimum value is 500.0 mmHg.

```
Send:         alarm baro pres min
Receive:      alarm baro pres min 500.0 mmHg
```

set alarm baro pres min *value*
set alarm baro pres max *value*
These commands set the barometric pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing barometric pressure alarm limits in millimeters of mercury. The following example sets the barometric pressure alarm maximum value to 800.0 mmHg.

```
Send:         set alarm baro pres max 800.0
Receive:      set alarm baro pres max 800.0 ok
```

---

alarm bench status
This command reports the current status of the bench as FAIL or OK. The following example reports that the bench status is OK.

```
Send:         alarm bench status
Receive:      alarm bench status ok
```

---

alarm beta count min
alarm beta count max
These commands report the current beta count alarm minimum and maximum value settings. The following example reports that the beta count alarm minimum value is 5000.

```
Send:         alarm beta count min
Receive:      alarm beta count min 5000
```

set alarm beta count min *value*
set alarm beta count max *value*
These commands set the beta count alarm minimum and maximum *value*, where *value* is an integer number representing beta count limits. The following example sets the beta count alarm maximum value to 20000.

```
Send:         set alarm beta count max 20000
Receive:      set alarm beta count max 20000 ok
```

---

alarm board temp min
alarm board temp max
These commands report the current board temperature alarm minimum and maximum value settings. The following example reports that the board temperature alarm minimum value is 0 °C.

```
Send:         alarm board temp min
Receive:      alarm board temp min 0.0 degC
```

set alarm board temp min *value*
set alarm board temp max *value*
These commands set the board temperature alarm minimum and maximum values to *value*, where *value* is a floating-point number representing board temperature alarm limits in °C. The following example sets the board temperature alarm maximum value to 38 °C.

```
Send:         set alarm board temp max 38.0
Receive:      set alarm board temp max 38.0 ok
```

---

alarm conc avg pm min a/b
alarm conc avg pm max a/b
These commands report the current 24-hour average PM concentration alarm minimum and maximum values setting. The following example reports that the average PM concentration minimum is 100 mg/m^3.

```
Send:         alarm conc avg pm min a
Receive:      alarm conc avg pm min a 1.000E+02 mg/m3

Send:         alarm conc avg pm min b
Receive:      alarm conc avg pm min b 1.000E+02 mg/m3
```

set alarm conc avg pm min a/b *value*
set alarm conc avg pm max a/b *value*
These commands set the 24-hour average PM concentration alarm minimum and maximum values to *value*, where *value* is a floating-point representation of the concentration alarm limits. Values must be in the units that are currently set for use. The following example sets the average PM concentration alarm maximum value to 10000 mg/m^3.

```
Send:         set alarm conc avg pm max a 10000
Receive:      set alarm conc avg pm max a 10000 ok

Send:         set alarm conc avg pm max b 10000
Receive:      set alarm conc avg pm max b 10000 ok
```

alarm conc inst pm min a/b
alarm conc inst pm max a/b
These commands report the current 24-hour instant PM concentration alarm minimum and maximum values setting. The following example reports that the instant PM concentration minimum is 100 μg/m^3.

```
Send:        alarm conc inst pm min a
Receive:     alarm conc inst pm min a 1.000E+02 μg/m3

Send:        alarm conc inst pm min b
Receive:     alarm conc inst pm min b 1.000E+02 μg/m3
```

set alarm conc inst pm min a/b *value*
set alarm conc inst pm max a/b *value*
These commands set the 24-hour instant PM concentration alarm minimum and maximum values to *value*, where *value* is a floating-point representation of the concentration alarm limits. Values must be in the units that are currently set for use. The following example sets the instant PM concentration alarm maximum value to 10000 μg/m^3.

```
Send:        set alarm conc inst pm max a 10000
Receive:     set alarm conc inst pm max a 10000 ok

Send:        set alarm conc inst pm max b 10000
Receive:     set alarm conc inst pm max b 10000 ok
```

alarm filter tape status a/b
This command reports the status of the filter tape as FAIL or OK. The following example reports that the filter tape status is OK.

```
Send:        alarm filter tape status a
Receive:     alarm filter tape status a ok

Send:        alarm filter tape status b
Receive:     alarm filter tape status b ok
```

alarm flow min a/b
alarm flow max a/b
These commands report the current flow alarm minimum and maximum value settings. The following example reports that the flow alarm minimum value is 16.0 LPM.

```
Send:        alarm flow min a
Receive:     alarm flow min a 16.00 LPM

Send:        alarm flow min b
Receive:     alarm flow min b 16.00 LPM
```

set alarm flow min a/b *value*
set alarm flow max a/b *value*
These commands set the flow alarm minimum and maximum values to value, where value is a floating-point number representing flow alarm

limits in liters per minute/liters per hour. The following example sets the flow alarm maximum value to 17.34 LPM.

```
Send:         set alarm flow max a 17.34
Receive:      set alarm flow max a 17.34 ok

Send:         set alarm flow max b 17.34
Receive:      set alarm flow max b 17.34 ok
```

---

alarm flow pres min a/b
alarm flow pres max a/b
These commands report the current flow pressure alarm minimum and maximum value settings. The following example reports that the flow pressure alarm minimum value is -10.0 mmHg.

```
Send:         alarm flow pres min a
Receive:      alarm flow pres min a -10.0 mmHg

Send:         alarm flow pres min b
Receive:      alarm flow pres min b -10.0 mmHg
```

set alarm flow pres min a/b *value*
set alarm flow pres max a/b *value*
These commands set the flow pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing flow pressure alarm limits in millimeters of mercury. The following example sets the flow pressure alarm maximum value to 100.0 mmHg.

```
Send:         set alarm flow pres max a 100.0
Receive:      set alarm flow pres max a 100.0 ok

Send:         set alarm flow pres max b 100.0
Receive:      set alarm flow pres max b 100.0 ok
```

---

alarm flow temp min a/b
alarm flow temp max a/b
This command reports the current flow temperature alarm maximum value setting. The following example reports that the flow temperature alarm minimum value is 20.0 °C.

```
Send:         alarm flow temp min a
Receive:      alarm flow temp min a 20.0 degC

Send:         alarm flow temp min b
Receive:      alarm flow temp min b 20.0 degC
```

set alarm flow temp min a/b *value*
set alarm flow temp max a/b *value*
This command sets the flow temperature alarm maximum value to *value*, where *value* is a floating-point number representing flow temperature alarm limits in °C. The following example sets the flow temperature alarm maximum value to 70 °C.

```
Send:         set alarm flow temp max a 70.0
Receive:      set alarm flow temp max a 70.0 ok

Send:         set alarm flow temp max b 70.0
Receive:      set alarm flow temp max b 70.0 ok
```

alarm ib status

This command reports the status of the interface board as FAIL or OK. The following example reports that the interface board status is OK.

```
Send:         alarm ib status
Receive:      alarm ib status ok
```

alarm io status

This command reports the status of the I/O expansion board as FAIL or OK. The following example reports that the I/O expansion board status is OK.

```
Send:         alarm io status
Receive:      alarm io status ok
```

alarm mb status

This command reports the status of the motherboard as FAIL or OK. The following example reports that the motherboard status is OK.

```
Send:         alarm mb status
Receive:      alarm mb status ok
```

alarm sample rh min a/b
alarm sample rh max a/b

These commands report the current sample relative humidity alarm minimum and maximum value settings. The following example reports that the sample relative humidity alarm minimum value is 5%.

```
Send:         alarm sample rh min a
Receive:      alarm sample rh min a 5.0%

Send:         alarm sample rh min b
Receive:      alarm sample rh min b 5.0%
```

set alarm sample rh min a/b *value*
set alarm sample rh max a/b *value*

These commands set the sample relative humidity alarm minimum and maximum values to *value*, where *value* is a floating-point number representing sample relative humidity alarm limits in percent. The following example sets the sample relative humidity alarm maximum value to 40%.

```
Send:         set alarm sample rh max a 40.0
Receive:      set alarm sample rh max a 40.0 ok

Send:         set alarm sample rh max b 40.0
```

```
Receive:      set alarm sample rh max b 40.0 ok
```

alarm status det a/b
This command reports the board status of the detector as FAIL or OK. The following example reports that the detector board status is OK.

```
Send:         alarm status det a
Receive:      alarm status det a ok

Send:         alarm status det b
Receive:      alarm status det b ok
```

alarm tape counter max
This command reports the current filter tape count alarm maximum value setting. The following example reports that the filter tape count alarm maximum value is 480.

```
Send:         alarm tape counter max
Receive:      alarm tape counter max 480
```

set alarm tape counter max *value*
This command sets the filter tape count alarm maximum *value*, where *value* is an integer number representing filter tape alarm limits. The following example sets the filter tape count alarm maximum value to 490.

```
Send:         set alarm tape counter max 490
Receive:      set alarm tape counter max 490 ok
```

alarm vac pres min a/b
alarm vac pres max a/b
These commands report the current vacuum pressure alarm minimum and maximum value settings. The following example reports that the vacuum pressure alarm minimum value is -20.0 mmHg.

```
Send:         alarm vac pres min a
Receive:      alarm vac pres min a -20.0 mmHg

Send:         alarm vac pres min b
Receive:      alarm vac pres min b -20.0 mmHg
```

set alarm vac pres min a/b *value*
set alarm vac pres max a/b *value*
These commands set the vacuum pressure alarm minimum and maximum values to *value*, where *value* is a floating-point number representing vacuum pressure alarm limits in millimeters of mercury. The following example sets the vacuum pressure alarm maximum value to 250.0 mmHg.

```
Send:         set alarm vac pres max a 250.0
Receive:      set alarm vac pres max a 250.0 ok
```

```
Send:       set alarm vac pres max b 250.0
Receive:    set alarm vac pres max b 250.0 ok
```

Diagnostics

amb rh

This command reports the ambient RH, in percent. The following example reports that the ambient RH is 30%.

```
Send:       amb rh
Receive:    amb rh 30.0%
```

amb temp

This command reports the current ambient temperature, in degrees C. The following example reports that the ambient temperature is 15 °C.

```
Send:       amb temp
Receive:    amb temp 15.0 degC
```

baro pres

This command reports the current barometric pressure, in mmHg. The following example reports that the barometric pressure is 722 mmHg.

```
Send:       baro pres
Receive:    baro pres 722.0 mmHg
```

board temp

This command reports the current board temperature, in degrees C. The following example reports that the board temperature is 15 °C.

```
Send:       board temp
Receive:    board temp 15.0 degC
```

crn a/b

This command reports the current radon concentration for the detector. The following example reports that the radon concentration is 1.2 Bq/ m^3.

```
Send:       crn a
Receive:    crn a 1.20 Bq/m3

Send:       crn b
Receive:    crn b 1.20 Bq/m3
```

det status a/b

This command reports the current mass for the detector. The sequence is: βc, β, α. Each value is separated by a space.

```
Send:       det status a
Receive:    det status a 30000 25000 500

Send:       det status b
Receive:    det status b 30000 25000 500
```

diag volt det a/b
This command reports the diagnostic voltage measurements on the detector board. The voltage is positive 5.

```
Send:         diag volt det a
Receive:      diag volt det a 4.9

Send:         diag volt det b
Receive:      diag volt det b 4.9
```

diag volt iob
This command reports the diagnostic voltage measurements on the I/O expansion board. The sequence of voltages is: Positive 24, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

```
Send:         diag volt iob
Receive:      diag volt iob 24.10 4.90 3.20 -3.20
```

diag volt mb
This command reports the diagnostic voltage measurements on the motherboard. The sequence of voltages is: Positive 24, positive 15, positive 5, positive 3.3, and negative 3.3. Each voltage value is separated by a space.

```
Send:         diag volt mb
Receive:      diag volt mb 24.10 14.90 4.90 3.20 -3.20
```

diag volt mib
This command reports the diagnostic voltage measurements on the measurement interface board. The sequence of voltages is: Positive 24, positive 15, negative 15, positive 5, and positive 3.3. Each voltage value is separated by a space.

```
Send:         diag volt mib
Receive:      diag volt mib 24.98 14.80 -14.90 4.96 3.20
```

diag volt neph
This command reports the diagnostic voltage measurements on the nephelometer interface board.

```
Send:         diag volt neph
Receive:      diag volt neph
```

flow a/b
This command reports the current sample flow. The following example reports that the sample flow is 16.69 LPM.

```
Send:         flow a
Receive:      flow a 16.69 LPM
```

```
Send:        flow b
Receive:     flow b 16.69 LPM
```

---

flow pres a/b

This command reports the current flow pressure for the detector, in mmHg. The following example reports that the flow pressure is 24.1 mmHg.

```
Send:        flow pres a
Receive:     flow pres a 24.1 mmHg

Send:        flow pres b
Receive:     flow pres b 24.1 mmHg
```

---

flow temp a/b

This command reports the current flow temperature for the detector, in degrees C. The following example reports that the flow temperature is 22.3 °C.

```
Send:        flow temp a
Receive:     flow temp a 22.3 deg

Send:        flow temp b
Receive:     flow temp b 22.3 deg
```

---

io bd

This command reports the presence of the I/O expansion board (yes/no). The following example reports the I/O expansion board is present (yes).

```
Send:        io bd
Receive:     io bd yes
```

---

mass a/b

This command reports the presence of mass. The following example reports that the mass is 0.1 mg/m^3.

```
Send:        mass a
Receive:     mass a 0.1 mg/m3

Send:        mass b
Receive:     mass b 0.1 mg/m3
```

---

set reset tape counter a/b

This command resets the tape count to zero.

```
Send:        set reset tape counter a
Receive:     set reset tape counter a ok

Send:        set reset tape counter b
Receive:     set reset tape counter b ok
```

sample rh a/b
This command reports the sample RH, in percent. The following example reports that the sample RH is 20%.

```
Send:         sample rh a
Receive:      sample rh a 20.0%

Send:         sample rh b
Receive:      sample rh b 20.0%
```

tape counter a/b
This command reports the number counts which corresponds to the filter tape movement. The following example reports that the tape count is 250.

```
Send:         tape counter a
Receive:      tape counter a 250

Send:         tape counter b
Receive:      tape counter b 250
```

vac pres a/b
This command reports the current vacuum pressure for the detector, in mmHg. The following example reports that the vacuum pressure is 100 mmHg.

```
Send:         vac pres a
Receive:      vac pres a 100.0 mmHg

Send:         vac pres b
Receive:      vac pres b 100.0 mmHg
```

vac pres offset a/b
This command reports the vacuum pressure offset. The following example gets the vacuum pressure offset -1.4.

```
Send:         vac pres offset a
Receive:      vac pres offset a -1.4

Send:         vac pres offset b
Receive:      vac pres offset b -1.4
```

purge mode a/b
This command get purge mode.The following example get purge mode.

```
Send:         purge mode a
Receive:      purge mode a 1.000

Send:         purge mode b
Receive:      purge mode b 1.000
```

set purge mode a/b on
This command sets purge mode on. The following example set purge mode on.

```
Send:        set purge mode a on
Receive:     set purge mode a on ok

Send:        set purge mode b on
Receive:     set purge mode b on ok
```

Datalogging

clr records

This command will clear all lrecs and srecs that have been saved.

```
Send:        clr records
Receive:     clr records ok
```

set clr lrecs
set clr srecs

These commands will clear only the lrecs or only the srecs that have been saved. The following example clears srecs.

```
Send:        set clr srecs
Receive:     set clr srecs ok
```

set copy sp to lrec
set copy sp to srec
set copy sp to stream

These commands copy the current selections in scratch pad (sp) into the lrec, srec, or streaming data list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. For more information on how to edit the scratch pad, see the "sp field" command.

The following example copies the current list in scratch pad into the lrecs list.

```
Send:        set copy sp to lrec
Receive:     set copy sp to lrec ok
```

set copy lrec to sp
set copy srec to sp
set copy stream to sp

These commands copy the current contents of the lrec, srec, or streaming data list into the scratch pad (sp). These commands are useful in easy modification of current lrec, srec, or streaming data lists.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. For more information on how to edit the scratch pad, see the "sp field" command.

The following example copies the current list of lrecs into the scratch pad.

```
Send:         set copy lrec to sp
Receive:      set copy lrec to sp ok
```

---

data treatment lrec
data treatment srec

These commands report the current selection of data treatment for concentrations in the lrecs or srecs. The following example reports the data treatment for concentrations in lrec as minimum.

```
Send:         data treatment lrec
Receive:      data treatment lrec min
```

set data treatment lrec *string*
set data treatment srec *string*
string = | cur | avg | min | max |

These commands set the data treatment to current, average, minimum, or maximum for the concentration values recorded in the lrecs or srecs. The following example sets the data treatment for concentrations in lrec as minimum.

```
Send:         set data treatment lrec min
Receive:      set data treatment lrec min ok
```

---

erec
er*xy*
x = | 0 | 1 | : Reply termination format (see "set format *format*" command)
y = | 0 | 1 | 2 | : Output format (see "set erec format *format*" command)

These commands return a snapshot of the main operating conditions (measurements and status) at the time the command is issued. The following example shows a typical response.

The format is defined within the command (in the case of erxy) by the current settings of the "format" and "erec format" commands (in the case of erec). For details on erec formatting, see the "Record Layout Definition" section at the end of this appendix. For details on how to decode the flag fields within these records, see the "flags" command.

```
Send:         erec
Receive:      erec
              07:53 05-04-09 flags 110000 PM 0.000 1 24Hr Avg PM
              0.000 1 Coef A 1.000 Bkg A 0.000 Range A 10000.000
              Flow A 0.000 6 5 3 1 1 1 0 Temp Threshold A 30.000
              Temp Threshold A 35.000
```

list lrec
list srec
list stream
list sp
These commands report the list of current selections for lrec logging data, srec logging data, streaming data output, or the scratch pad (sp) list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list. Refer to the "sp field" command for information on how to edit the scratch pad.

The following example shows the list for streaming data output.

```
Send:          list stream
Receive:       list stream
               field index variable
                X  x time
```

lrec
srec
lrec *rec num*
srec *rec num*
lr*xy rec num*
sr*xy rec num*
lrec *aa:bb oo-pp-qq yy*
srec *aa:bb oo-pp-qq yy*
rec = The starting record index number (1=most recent)
num = The number of records to return (1 to 10)
x = | 0 | 1 | : Reply termination format (see "set format format" command)
y = | 0 | 1 | 2 | : Output format (see "set lrec/srec format format" command)
aa = hours (01 to 23)
bb = minutes (01 to 59)
oo = month (01 to 12)
pp = day (01 to 31)
qq = year

These commands output lrec or srec logged data. The output format is determined by the "set lrec format", and "set srec format" commands. The logging time is determined by the "set lrec per" and "set srec per" commands.

In the following example, assume there are 740 lrecs currently stored in memory. When the command "lrec 100 5" is sent, the instrument counts back 100 records from the last record collected (record 740), and then returns 5 records: 640, 641, 642, 643, and 644. For details on how to decode the flag fields within these records, see the "flags" command.

```
Send:       lrec 5
Receive:    lrec 100 5
            08:28 05-04-09 flags 00110000 pm 0.000 baro 0.000 vac
            -260.000 pflow -52.000 ambrh 0.000 srh 0.000 ambtemp
            -32.000 stemp -41.000 fvol 0.000 cflg 00001F86 aflg
            0000FC0C
            08:29 05-04-09 flags 00110000 pm 0.000 baro 0.000 vac
            -260.000 pflow -52.000 ambrh 0.000 srh 0.000 ambtemp
            -32.000 stemp -41.000 fvol 0.000 cflg 00001F86 aflg
            0000FC0C
            08:30 05-04-09 flags 00110000 pm 0.000 baro 0.000 vac
            -260.000 pflow -52.000 ambrh 0.000 srh 0.000 ambtemp
            -32.000 stemp -41.000 fvol 0.000 cflg 00001F86 aflg
            0000FC0C
            08:31 05-04-09 flags 00110000 pm 0.000 baro 0.000 vac
            -260.000 pflow -52.000 ambrh 0.000 srh 0.000 ambtemp
            -32.000 stemp -41.000 fvol 0.000 cflg 00001F86 aflg
            0000FC0C
            08:32 05-04-09 flags 00110000 pm 0.000 baro 0.000 vac
            -260.000 pflow -52.000 ambrh 0.000 srh 0.000 ambtemp
            -32.000 stemp -41.000 fvol 0.000 cflg 00001F86 aflg
            0000FC0C
```

lrec format
srec format
erec format

These commands report the output format for lrecs and srecs, and erec data in various formats such as ASCII without text, ASCII with text, or binary. The following example shows the output format for lrecs is ASCII with text, according to Table B–3.

```
Send:       lrec format
Receive:    lrec format 1
```

set lrec format *format*
set srec format *format*
set erec format *format*

These commands set the output format for lrecs and srecs, and erec data, according to Table B–3. The following example sets the lrec output format to ASCII with text.

```
Send:       set lrec format 1
Receive:    set lrec format 1 ok
```

Table B–3. Record Output Formats

Format	**Output Format**
0	ASCII no text
1	ASCII with text
2	Binary data

lrec layout
srec layout
erec layout
These commands report the layout (string indicating the data formats) for data that is sent out in response to the lrec, srec, erec, and related commands. For details on how to interpret the strings, see "Record Layout Definition" later in this appendix.

```
Send:         lrec layout
Receive:      lrec layout %s %s %lx %f %f %f %f %f %f %f %f %f
              %lx %lx
              t D L fffffffff A A
              flags pm baro vac pflow ambrh srh ambtemp stemp fvol
              dflg aflg
```

lrec mem size
srec mem size
These commands report the number of lrecs and srecs that can be stored with the current settings and the number of blocks reserved for lrecs and srecs. The following example shows that 1075 blocks were reserved for lrecs and the maximum number of lrecs that can be stored in memory is 241979. Memory allocation can be changed using the "malloc" command.

```
Send:         lrec mem size
Receive:      lrec mem size 241979 recs, 1075 blocks
```

lrec per
srec per
These commands report the lrecs and srecs logging period. The following example shows that the srec logging period is 5 minutes.

```
Send:         srec per
Receive:      srec per 5 min
```

set lrec per *value*
set srec per *value*
value = | 1 | 5 | 15 | 30 | 60 |

These commands set the lrecs and srecs logging period to *value* in minutes. The following example sets the lrec logging period to 15 minutes.

```
Send:         set lrec per 15
Receive:      set lrec per 15 ok
```

malloc lrec
malloc srec
These commands report the currently set memory allocation for lrecs and srecs in percent of total memory.

```
Send:         malloc lrec
Receive:      malloc lrec 10 %
```

set malloc lrec *value*
set malloc srec *value*
value = 0 to 100

These commands set the percent of memory space allocated for lrecs and sreco to value, where value is a floating-point number representing percent. The following example sets the memory allocation for lrecs to 10%.

Note Issuing these commands will clear all the logged data in memory. All the existing records should be retrieved using appropriate commands, if required. ▲

```
Send:         set malloc lrec 10
Receive:      set malloc lrec 10 ok
```

---

no of lrec
no of srec
These commands report the number of lrec and srecs stored memory. The following example shows that 50 lrecs have been stored in the memory.

```
Send:         no of lrec
Receive:      no of lrec 50 recs
```

---

sp field *number*
This command reports the variable *number* and name stored at the index in the scratch pad list.

The scratch pad is a temporary memory area which is used to set up lists of selections for lrec, srec, or streaming data items. The user can copy any of these lists to the scratch pad, modify individual elements in the list, then save the scratch pad back to the original list.

The following example shows that field 1 in the scratch pad is set to index number 3, which is for the variable PM concentration pressure.

```
Send:         sp field 1
Receive:      sp field 1 3 PM
```

set sp field *number value*
number = 1-32 for lrec and srec lists, 1-8 for streaming data lists

This command sets the scratch pad field *number* (item number in scratch pad list) to *value*, where *value* is the index number of a variable in the analog output variable list. Available variables and their corresponding index numbers may be obtained using the command "list var aout". The "set sp field" command is used to create a list of variables which can then be transferred into the lrec, srec, or streaming data lists, using the “set copy sp to lrec”, “set copy sp to srec”, or “set copy sp to stream” commands.

```
Send:         set sp field 1 34
Receive:      set sp field 1 34 ok
```

---

stream per
This command reports the current time interval in seconds for streaming data. The following example reports the streaming period is set to 10 seconds.

```
Send:         stream per
Receive:      stream per 10 sec
```

set stream per *number value*
number value = | 1 | 2 | 5 | 10 | 20 | 30 | 60 | 90 |120 | 180 | 240 | 300 |

This command sets the time interval between two consecutive streaming data strings to *number value* in seconds. The following example sets the number value to 10 seconds.

```
Send:         set stream per 10
Receive:      set stream per 10 ok
```

---

stream time
This command reports if the streaming data string will have a time stamp attached to it or not, according to Table B–4. The following example reports that the streaming data shall not include a time stamp.

```
Send:         stream time
Receive:      stream time 0
```

set stream time *value*
This command enables *value*, where *value* is to attach or disable time stamp to streaming data string, according to Table B–4. The following example attaches a time stamp to streaming data.

```
Send:         set stream time 1
Receive:      set stream time 1 ok
```

Table B–4. Stream Time Values

Value	**Stream Time**
0	Disables time stamp to streaming data string
1	Attaches time stamp to streaming data string

Calibration

alpha eff a/b
This command reports the current value of alpha efficiency for the detector. The following example reports that the alpha efficiency is 0.12.

```
Send:        alpha eff a
Receive:     alpha eff a 0.120

Send:        alpha eff b
Receive:     alpha eff b 0.120
```

set alpha eff a/b *value*
This command sets the alpha efficiency for the detector to *value*, where *value* is a floating-point number representing the alpha efficiency for the detector. The following example sets the alpha efficiency to.0.15.

```
Send:        set alpha eff a 0.15
Receive:     set alpha eff a 0.150 ok

Send:        set alpha eff b 0.15
Receive:     set alpha eff b 0.150 ok
```

alpha th a/b
This command reports the current value of alpha threshold for the detector. The following example reports that the alpha threshold is 1220.

```
Send:        alpha th a
Receive:     alpha th a 1220

Send:        alpha th b
Receive:     alpha th b 1220
```

set alpha th a/b *value*
This command sets the alpha threshold for the detector to *value*, where *value* is a floating-point number representing the alpha threshold for the detector. The following example sets the alpha threshold to 1250.

```
Send:        set alpha th a 1250
Receive:     set alpha th a 1250 ok

Send:        set alpha th b 1250
Receive:     set alpha th b 1250 ok
```

amb rh offset
This command reports the current ambient RH offset, in percent. The following example reports that the ambient RH offset is 0.6%.

```
Send:        amb rh offset
Receive:     amb rh offset 0.6%
```

set amb rh offset *value*
This command sets the ambient RH offset to *value*, where *value* is a floating-point number representing ambient RH offset in percent. The following example sets the ambient RH offset to 7%.

```
Send:        set amb rh offset 7
Receive:     set amb rh offset 7 ok
```

---

amb temp offset
This command reports the current ambient temperature offset, in degrees C. The following example reports that the ambient temperature offset is 5 °C.

```
Send:        amb temp offset
Receive:     amb temp offset 5.0 degC
```

set amb temp offset *value*
This command sets the ambient temperature offset to *value*, where *value* is a floating-point number representing ambient temperature offset in degrees C. The following example sets the ambient temperature offset to 3 °C.

```
Send:        set amb temp offset 3
Receive:     set amb temp offset 3 ok
```

---

baro mass coef a/b
This command reports the current barometric mass coefficient. The following example reports that the barometric mass coefficient is 0.000540.

```
Send:        baro mass coef a
Receive:     baro mass coef a 0.000540

Send:        baro mass coef b
Receive:     baro mass coef b 0.000540
```

set baro mass coef a/b *value*
This command sets the barometric mass coefficient to user-defined values to *value*, where *value* is a floating-point representation of the coefficient. The following example sets the barometric mass coefficient to 0.000630.

```
Send:        set baro mass coef a 0.000630
Receive:     set baro mass coef a 0.000630 ok

Send:        set baro mass coef b 0.000630
Receive:     set baro mass coef b 0.000630 ok
```

baro span
This command reports the current barometric pressure span recorded at the time of calibration. The following example reports that the barometric span is 1.0.

```
Send:         baro span
Receive:      baro span 1.0000
```

set baro span *value*
This command requires to manually specifying the span *value* for the barometric pressure span,where *value* is a floating-point representation of barometric pressure span. The following example successfully sets the barometric span to 1.023.

```
Send:         set baro span 1.023
Receive:      set baro span 1.023 ok
```

beta th a/b
This command reports the current reference beta threshold for the detector. The following example reports that the beta threshold is 440.

```
Send:         beta th a
Receive:      beta th a 440

Send:         beta th b
Receive:      beta th b 440
```

set beta th a/b *value*
This command sets the reference beta threshold for the detector to *value*, where *value* is a floating-point representation of the beta threshold. The following example sets the beta threshold to 500.

```
Send:         set beta th a 500
Receive:      set beta th a 500 ok

Send:         set beta th b 500
Receive:      set beta th b 500 ok
```

bkg pm a/b
This command reports the current PM backgrounds. The following example reports that the PM background is 4 μg/m^3.

```
Send:         bkg pm a
Receive:      bkg pm a 4.000E+00 μg/m3

Send:         bkg pm b
Receive:      bkg pm b 4.000E+00 μg/m3
```

set bkg pm a/b *value*
This command is used to set PM backgrounds to user-defined values to *value*, where *value* is a floating-point representation of the background

in current selected units. The following example sets the PM background to 5.2 μg/m^3.

```
Send:        set bkg pm a 5.2
Receive:     set bkg pm a 5.2 ok

Send:        set bkg pm b 5.2
Receive:     set bkg pm b 5.2 ok
```

set cal baro pres span
This command automatically calculates the span coefficient based on the entered target pressure value. The following example sets the calibration pressure to 720.5 mmHg.

```
Send:        set cal baro pres span 720.5
Receive:     set cal baro pres span 720.5 ok
```

set cal flow pres span a/b
This command automatically sets the flow pressure span based on the flow pressure entered at the time of calibration. The following example successfully sets the new value for flow span based on the flow pressure to 50.5 mmHg.

```
Send:        set cal flow pres span a 50.5
Receive:     set cal flow pres span a 50.5 ok

Send:        set cal flow pres span b 50.5
Receive:     set cal flow pres span b 50.5 ok
```

set cal flow span a/b
This command automatically sets the new value for flow span based on the corrected flow entered. The following example sets the new value for flow span based on the corrected flow to 17.2 LPM.

```
Send:        set cal flow span a 17.2
Receive:     set cal flow span a 17.2 ok

Send:        set cal flow span b 17.2
Receive:     set cal flow span b 17.2 ok
```

set cal vac pres span a/b
This command automatically sets the vacuum span based on the vacuum pressure entered at the time of calibration. The following example successfully sets the new value for vacuum span based on the vacuum pressure to 120.5 mmHg.

```
Send:        set cal vac pres span a 120.5
Receive:     set cal vac pres span a 120.5 ok

Send:        set cal vac pres span b 120.5
Receive:     set cal vac pres span b 120.5 ok
```

set cal vac flow offset a/b
This command automatically sets the flow offset based on the vacuum pressure entered at the time of calibration. The following example successfully sets the flow offset value.

```
Send:         set cal vac flow offset a
Receive:      set cal vac flow offset a ok

Send:         set cal vac flow offset b
Receive:      set cal vac flow offset b ok
```

coef pm a/b
This command reports PM coefficient. The following example reports that the PM coefficient is 1.200.

```
Send:         coef pm a
Receive:      coef pm a 1.200

Send:         coef pm b
Receive:      coef pm b 1.200
```

set coef pm a/b *value*
This command sets the PM coefficient to user-defined values to *value*, where *value* is a floating-point representation of the coefficient. The following example sets the PM coefficient to 1.200.

```
Send:         set coef pm a 1.200
Receive:      set coef pm a 1.200 ok

Send:         set coef pm b 1.200
Receive:      set coef pm b 1.200 ok
```

flow pres span a/b
This command reports the flow pressure span recorded at the time of calibration. The following example reports that the flow span is 1.2.

```
Send:         flow pres span a
Receive:      flow pres span a 1.200

Send:         flow pres span b
Receive:      flow pres span b 1.200
```

set flow pres span a/b *value*
This command sets the flow pressure span to *value*, where *value* is a floating-point representation of the pressure span specified at the time of calibration. The following example successfully sets the new value for flow pressure to 1.5.

```
Send:         set flow pres span a 1.5
Receive:      set flow pres span a 1.5 ok

Send:         set flow pres span b 1.5
Receive:      set flow pres span b 1.5 ok
```

flow pres offset

This command reports the flow pressure offset for the detector at the time of calibration. The following example reports that the flow pressure offset is 3.0.

```
Send:         flow pres offset
Receive:      flow pres offset 3.0
```

flow span a/b

This command reports the current flow span at the time of calibration. The following example reports that the flow at calibration is 1.00.

```
Send:         flow span a
Receive:      flow span a 1.000

Send:         flow span b
Receive:      flow span b 1.000
```

set flow span a/b *value*

This command sets the current flow span to the *value*, where *value* is a floating-point representation of the flow span specified at the time of calibration. The following example sets the flow span to 1.5.

```
Send:         set flow span a 1.5
Receive:      set flow span a 1.5 ok

Send:         set flow span b 1.5
Receive:      set flow span b 1.5 ok
```

flow temp offset a/b

This command reports offset for flow temperature, in degrees C. The following example reports that the flow temperature offset is 5 °C.

```
Send:         flow temp offset a
Receive:      flow temp offset a 5.0 degC

Send:         flow temp offset b
Receive:      flow temp offset b 5.0 degC
```

set flow temp offset a/b *value*

This command sets the offset value for flow temperature, where value is a floating-point number representing flow temperature offset in degrees C. The following example sets the flow temperature offset to 7 °C.

```
Send:         set flow temp offset a 7
Receive:      set flow temp offset a 7 ok

Send:         set flow temp offset b 7
Receive:      set flow temp offset b 7 ok
```

high volt a/b

This command reports the current high voltage for the detector. The following example reports that the high voltage is 1400 V.

```
Send:        high volt a
Receive:     high volt a 1400

Send:        high volt b
Receive:     high volt b 1400
```

set high volt a/b *value*

This command sets the high voltage for the detector to *value*, where *value* is a floating-point representation of the high voltage. The following example sets the high voltage to 1445 V.

```
Send:        set high volt a 1445
Receive:     set high volt a 1445 ok

Send:        set high volt b 1445
Receive:     set high volt b 1445 ok
```

mass coef a/b

This command reports the current mass coefficient. The following example reports that the mass coefficient is 7100.

```
Send:        mass coef a
Receive:     mass coef a 7100

Send:        mass coef b
Receive:     mass coef b 7100
```

set mass coef a/b *value*

This command sets the mass coefficient to user-defined values to *value*, where *value* is a floating-point representation of the coefficient. The following example sets the mass coefficient to 7000.

```
Send:        set mass coef a 7000
Receive:     set mass coef a 7000 ok

Send:        set mass coef b 7000
Receive:     set mass coef b 7000 ok
```

thermal mass coef a/b

This command reports the current thermal mass coefficient. The following example reports that the thermal mass coefficient is 19.0000.

```
Send:        thermal mass coef a
Receive:     thermal mass coef a 19.0000

Send:        thermal mass coef b
Receive:     thermal mass coef b 19.0000
```

set thermal mass coef a/b *value*
This command sets the thermal mass coefficient to user-defined values to value, where value is a floating-point representation of the coefficient. The following example sets the thermal mass coefficient to 20.5.

```
Send:         set thermal mass coef a 20.5
Receive:      set thermal mass coef a 20.5 ok

Send:         set thermal mass coef b 20.5
Receive:      set thermal mass coef b 20.5 ok
```

---

vac mass coef a/b
This command reports the current vacuum mass coefficient. The following example reports that the vacuum mass coefficient is 2.0.

```
Send:         vac mass coef a
Receive:      vac mass coef a 2.0

Send:         vac mass coef b
Receive:      vac mass coef b 2.0
```

set vac mass coef a/b *value*
This command sets the vacuum mass coefficient to user-defined values to *value*, where *value* is a floating-point representation of the coefficient. The following example sets the vacuum mass coefficient to 3.1.

```
Send:         set vac mass coef a 3.1
Receive:      set vac mass coef a 3.1 ok

Send:         set vac mass coef b 3.1
Receive:      set vac mass coef b 3.1 ok
```

---

vac pres span a/b
This command reports the vacuum span for the detector at the time of calibration. The following example reports that the vacuum pressure span is 1.0.

```
Send:         vac pres span a
Receive:      vac pres span a 1.000

Send:         vac pres span b
Receive:      vac pres span b 1.000
```

set vac pres span a/b *value*
This command sets the vacuum span to the value specified at the time of calibration. The following example successfully sets the new value for vacuum pressure span to 1.002.

```
Send:         set vac pres span a 1.002
Receive:      set vac pres span a 1.002 ok

Send:         set vac pres span b 1.002
Receive:      set vac pres span b 1.002 ok
```

set vf pres cal def
This command resets the vacuum and flow pressure calibration to their default values.The following example resets the vacuum and flow pressure calibration to default values.

```
Send:         set vf pres cal def
Receive:      set vf pres cal def ok
```

tape to ncal ratio a/b
This command gets tape / zero ratio.The following example gets tape / zero ratio 1.000.

```
Send:         tape to ncal ratio a
Receive:      tape to ncal ratio a 1.000

Send:         tape to ncal ratio b
Receive:      tape to ncal ratio b 1.000
```

set tape to ncal ratio a/b *value*
This command sets the value of tape / zero ratio.The following example sets tape / zero ratio to 70.

```
Send:         set tape to ncal ratio a 70
Receive:      set tape to ncal ratio a 70 ok

Send:         set tape to ncal ratio b 70
Receive:      set tape to ncal ratio b 70 ok
```

Keys/Display

push *button*

do	**me**	**1**
down	**menu**	**2**
en	**ri**	**3**
enter	**right**	**4**
he	**ru**	
help	**run**	
le	**up**	
left		

button = | do | down | en | enter | he | help | le | left | me | menu | ri | right | ru | run | up | 1 | 2 | 3 | 4 |

These commands simulate pressing the front panel pushbuttons. The numbers represent the front panel soft keys, from left to right.

```
Send:         push enter
Receive:      push enter ok
```

isc
iscreen
These commands retrieve the framebuffer data used for the display on the iSeries instrument. It is 19200 bytes in size, 2-bits per pixel, 4 pixels per byte arranged as 320 by 240 characters. The data is sent in RLE

encoded form to save time in transmission. It is sent as a type ‘5’ binary C-Link response with no checksum.

The RLE encoding consists of a 0 followed by an 8-bit count of consecutive 0xFF bytes. The following ‘c’ code will expand the incoming data.

```
void      unpackDisplay ( void far* tdib, unsigned char far* rlescreen )
{
int i,j,k;
unsigned char far *sc4bpp, *sc2bpp, *screen, *ptr;

   ptr = screen = (unsigned char far *)malloc(19200);
   //RLE decode the screen
   for (i=0; i<19200 && (ptr - screen) < 19200; i++)
   {
      *(ptr++) = *(rlescreen + i);
      if (*(rlescreen + i) == 0)
      {
         unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);
         while (rlecount)
         {
            *(ptr++) = 0;
            rlecount--;
         }
      }
      else if (*(rlescreen + i) == 0xff)
      {
         unsigned char rlecount = *(unsigned char *)(rlescreen + ++i);

         while (rlecount)
         {
            *(ptr++) = 0xff;
            rlecount--;
         }
      }
   }
}
```

To convert this data into a BMP for use with Windows, it needs to be saved as a 4-bit-per-pixel gray-scale image. Also note that BMP files are upside down relative to this data, that is, the top display line is the last line in the BMP.

---

sc
screen
These commands are meant for backward compatibility with the C series. Screen information is instead reported using the “iscreen” command above.

```
Send:         screen
Receive:      screen This is an iSeries instrument.
              Screen information not available.
```

Measurement Configuration

conc unit
This command reports the current concentration units (mg/m^3 or µg/m^3). The following example reports that the concentration units are set to mg/m^3.

```
Send:        conc unit
Receive:     conc unit µg/m3
```

set conc unit *unit*
unit = | µg/m^3 | mg/m^3 |

This command sets the concentration units to mg/m^3 or µg/m^3. The following example sets the concentration units to mg/m^3.

```
Send:        set conc unit mg/m3
Receive:     set conc unit mg/m3 ok
```

custom *range*
range = | 1 | 2 | 3 |

This command reports the user-defined value of custom *range* 1, 2, or 3. The following example reports that custom range 1 is defined to 5.50 mg/m^3.

```
Send:        custom 1
Receive:     custom 1 5.500E+00 mg/m3
```

set custom *range* **range** *value*
set custom 1 *value*
set custom 2 *value*
set custom 3 *value*
These commands are used to set the maximum concentration for any of the three custom ranges 1, 2, or 3 to range *value*, where *value* is a floating-point number representing concentration in the currently selected units. The following example sets the custom 1 range to 100.5 µg/m^3.

```
Send:        set custom 1 100.5 µg/m3
Receive:     set custom 1 100.5 µg/m3 ok
```

filter period
This command reports the number of hours to be added to filter next time for the filter tape change. The following example reports that the filter period is eight hours.

```
Send:        filter period
Receive:     filter period 8 HRS
```

set filter period *value*
This command sets the number of hours to be added to filter next time for the filter tape change to value, where value is a floating-point representation of the filter period in hours. The following example sets the filter period to 10 hours.

```
Send:          set filter period 10
Receive:       set filter period 10 ok
```

---

set filter tape a/b move
This command sets filter tape movement. The following example set filter tape movement.

```
Send:          set filter tape a move
Receive:       set filter tape a move ok

Send:          set filter tape b move
Receive:       set filter tape b move ok
```

---

filter time
This command reports the next date and time of the filter tape change. The following example reports that the date and time is January 1, 2008, 6:12 pm.

```
Send:          filter time
Receive:       filter time 01Jan08 18:12
```

set filter time *dd-mm-yyyy hh:mm:ss*
dd = day
mm = month
yyyy = year
hh = hours
mm = minutes
ss = seconds

This command sets the next filter tape change. The following example sets the filter time to October 1, 2008, 11:32 pm.

```
Send:          set filter time 10-01-2008 23:32
Receive:       set filter time 10-01-2008 23:32 ok
```

---

flow target a/b
This command reports the current flow. The following example reports that the flow is 16.0 LPM.

```
Send:          flow target a
Receive:       flow target a 16.00

Send:          flow target b
Receive:       flow target b 16.00
```

set flow target a/b *value*
This command sets the flow to *value*, where *value* is a floating-point number representation of flow between 1 to 20 LPM. The following example sets the flow to 16.67 LPM.

```
Send:        set flow target a 16.67
Receive:     set flow target a 16.67 ok

Send:        set flow target b 16.67
Receive:     set flow target b 16.67 ok
```

---

ht control a/b
This command reports the current status of the heater (off, RH threshold, or temp threshold). The following example reports that the heater is RH threshold.

```
Send:        ht control a
Receive:     ht control a RH

Send:        ht control b
Receive:     ht control b RH
```

set ht control *selection* **a/b**
selection = | off | rh | temp |

This command sets the heater to off, RH threshold, or temp threshold. The following example sets the heater to temp threshold.

```
Send:        set ht control temp a
Receive:     set ht control temp a ok

Send:        set ht control temp b
Receive:     set ht control temp b ok
```

---

mass limit
This command reports the current filter mass limit. The following example reports that the mass limit is 1,500 mg.

```
Send:        mass limit
Receive:     mass limit 1500
```

set mass limit *value*
This command sets the filter mass limit to *value*, where *value* is a floating-point number representation of mass limit between 0.5 to 5.0 mg or 500 to 5,000 µg. The following example sets the mass limit to 1.0 mg.

```
Send:        set mass limit 1.0
Receive:     set mass limit 1.0 ok
```

pres comp

This command reports whether pressure compensation is for actual or standard conditions. The following example shows the pressure compensation is standard.

```
Send:       pres comp
Receive:    pres comp std
```

set pres comp *selection*

selection = | act | std |

These commands turn the pressure compensation to either actual or standard conditions. The following example turns the pressure compensation to actual.

```
Send:       set pres comp act
Receive:    set pres comp act ok
```

pres std a/b

This command reports the standard pressure. The following example reports that the standard pressure is 760 mmHg.

```
Send:       pres std a
Receive:    pres std a 760 mmHg

Send:       pres std b
Receive:    pres std b 760 mmHg
```

set pres std a/b *value*

This command sets the standard pressure to *value*, where *value* is a floating-point number representation of standard pressure between 0 to 760 mmHg. The following example sets the standard pressure to 730 mmHg.

```
Send:       set pres std a 730
Receive:    set pres std a 730 ok

Send:       set pres std b 730
Receive:    set pres std b 730 ok
```

range a/b

This command reports the current PM range. If the mode is incorrect, the instrument responds with "can't, wrong settings". The following example reports that the PM range is set to 5 mg/m^3, according to Table B–5.

```
Send:       range a
Receive:    range a 4: (5.000E+00 mg/m3)

Send:       range b
Receive:    range b 4: (5.000E+00 mg/m3)
```

set range a/b *selection*
This command selects the PM ranges, according to Table B–5. The following example sets the PM range to 10 mg/m^3.

```
Send:        set range a 5
Receive:     set range a 5 ok

Send:        set range b 5
Receive:     set range b 5 ok
```

Table B–5. Standard Ranges

Selection	µg/m3	mg/m3
0	100	0.1
1	1000	1.0
2	2000	2.0
3	3000	3.0
4	5000	5.0
5	10000	10.0
6	C1	C1
7	C2	C2
8	C3	C3

rh th a/b
This command reports the current heater RH threshold for the sample. The following example reports that the RH threshold is 30%.

```
Send:        rh th a
Receive:     rh th a 30%

Send:        rh th b
Receive:     rh th b 30%
```

set rh th a/b *value*
This command sets the heater RH threshold for the sample to *value*, where *value* is a floating-point number representation of RH threshold between 25 to 90%. The following example sets the RH threshold to 35%.

```
Send:        set rh th a 35
Receive:     set rh th a 35 ok

Send:        set rh th b 35
Receive:     set rh th b 35 ok
```

temp comp

This command reports whether temperature compensation is for actual or standard conditions. The following example shows the temperature compensation is standard.

```
Send:        temp comp
Receive:     temp comp std
```

set temp comp *selection*

selection = | act | std |

These commands turn the temperature compensation to either actual or standard conditions. The following example turns the temperature compensation to actual.

```
Send:        set temp comp act
Receive:     set temp comp act ok
```

temp std a/b

This command reports the standard temperature. The following example reports that the standard temperature is 18 °C.

```
Send:        temp std a
Receive:     temp std a 18 degC

Send:        temp std b
Receive:     temp std b 18 degC
```

set temp std a/b *value*

This command sets the standard temperature to *value*, where *value* is a floating-point number representation of standard temperature between 0 to 25 °C. The following example sets the standard temperature to 15 °C.

```
Send:        set temp std a 15
Receive:     set temp std a 15 ok

Send:        set temp std b 15
Receive:     set temp std b 15 ok
```

temp th a/b

This command reports the heater temperature threshold for the sample. The following example reports that the temperature threshold is 30 °C.

```
Send:        temp th a
Receive:     temp th a 30 degC

Send:        temp th b
Receive:     temp th b 30 degC
```

set temp th a/b *value*
This command sets the heater temperature threshold for the sample to *value*, where *value* is a floating-point number representation of temperature threshold between 0 to 70 °C. The following example sets the temperature threshold to 35 °C.

```
Send:         set temp th a 35
Receive:      set temp th a 35 ok

Send:         set temp th b 35
Receive:      set temp th b 35 ok
```

Hardware Configuration

contrast
This command reports the screen's level of contrast. The following example shows the screen contrast is 55%, according to Table B–6.

```
Send:         contrast
Receive:      contrast 11: 55%
```

set contrast *level*
This command sets the screen's level of contrast, according to Table B–6. The following example sets the contrast level to 50%.

```
Send:         set contrast 10
Receive:      set contrast 10 ok
```

Table B–6. Contrast Levels

Level	**Contrast Level**
0	0%
1	5%
2	10%
3	15%
4	20%
5	25%
6	30%
7	35%
8	40%
9	45%
10	50%
11	55%
12	60%
13	65%
14	70%
15	75%

Level	**Contrast Level**
16	80%
17	85%
18	90%
19	95%
20	100%

date
This command reports the current date. The following example reports the date as April 1, 2009.

```
Send:        date
Receive:     date 04-01-09
```

set date *mm-dd-yy*
mm = month
dd = day
yy = year

This command sets the date of the analyzer's internal clock. The following example sets the date to May 1, 2009.

```
Send:        set date 05-01-09
Receive:     set date 05-01-09 ok
```

set default params
This command sets all the parameters to their default values. This does not affect the factory-calibrated parameters.

```
Send:        set default params
Receive:     set default params ok
```

det
This command reports the status of the detector board (sharp/beta/map/none). The following example reports that the detector is beta.

```
Send:        det
Receive:     det beta
```

pump
This command reports the current status of pump as on or off. The following example reports that the pump is set to off.

```
Send:        pump
Receive:     pump off
```

set pump *onoff*
onoff = | on | off |

This command sets the pump *on* or *off*. The following example sets the pump to on.

```
Send:          set pump on
Receive:       set pump on ok
```

---

save
set save params
These commands store all current parameters in FLASH memory. It is important that each time instrument parameters are changed, that this command be sent. If changes are not saved, they will be lost in the event of a power failure. The following example saves the parameters to FLASH memory.

```
Send:          set save params
Receive:       set save params ok
```

---

time
This command reports the current time (24-hour format). The following example reports that the internal time is 2:15:30 pm.

```
Send:          time
Receive:       time 14:15:30
```

set time *hh:mm:ss*
hh = hours
mm = minutes
ss = seconds

This command sets the internal clock (24-hour format). The following example sets the internal time to 2:15 pm.

Note If seconds are omitted, the seconds default to 00. ▲

```
Send:          set time 14:15
Receive:       set time 14:15 ok
```

Communications Configuration

addr dns
This command reports the TCP/IP address for the domain name server.

```
Send:          addr dns
Receive:       addr dns 192.168.1.1
```

set addr dns *address*
This command sets the domain name server *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:        set addr dns 192.168.1.1
Receive:     set addr dns 192.168.1.1 ok
```

---

addr gw
This command reports the default TCP/IP gateway address.

```
Send:        addr gw
Receive:     addr gw 192.168.1.1
```

set addr gw *address*
This command sets the default gateway *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:        set addr gw 192.168.1.1
Receive:     set addr gw 192.168.1.1 ok
```

---

addr ip
This command reports the IP address of the analyzer.

```
Send:        addr ip
Receive:     addr ip 192.168.1.200
```

set addr ip *address*
This command sets the analyzer's IP *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:        set addr ip 192.168.1.200
Receive:     set addr ip 192.168.1.200 ok
```

---

addr nm
This command reports the IP netmask.

```
Send:        addr nm
Receive:     addr nm 255.255.252.0
```

set addr nm *mask*
This command sets the netmask *mask*, where *mask* consists of four numbers ranging from 0-255 inclusive, separated by ".".

Note This command cannot be used when DHCP is on. Refer to the DHCP command that follows for additional information. ▲

```
Send:         set addr nm 255.255.252.0
Receive:      set addr nm 255.255.252.0 ok
```

addr ntp

This command reports the IP address for the network time protocol server. See "Network Time Protocol Server" in the Communications Settings" section of the "Operation" chapter for more information.

```
Send:         addr ntp
Receive:      addr ntp 10.209.43.237
```

set addr ntp *address*

This command sets the network time protocol server *address*, where *address* consists of four numbers ranging from 0-255 inclusive, separated by ".".

```
Send:         set addr ntp 10.209.43.237
Receive:      set addr ntp 10.209.43.237 ok
```

allow mode cmd

This command reports the current allow mode setting: 1 = allow "set mode local" and "set mode remote" commands; 0 = ignore "set mode local" or "set mode remote"commands, according to Table B–7. The default value is 0; ignore the commands. The following example shows that the instrument is configured to ignore "set mode local" or "set mode remote" commands.

```
Send:         allow mode cmd
Receive:      allow mode cmd 0
```

set allow mode cmd *value*

This command is used to configure the instrument to *value*, where *value* is either 1 = accept or 0 = ignore the "set mode local" and "set mode remote" commands, according to Table B–7.

If the instrument is set to accept the commands (*value* = 1), the "set mode local" command will unlock the instrument and the keypad can be used to make changes via the front panel.

If the instrument is set to ignore the commands (*value* = 0), the instrument will respond with "ok" as if the command has been accepted and acted upon, **but will not change the instrument lock status** (this is for compatibility with systems expecting and "ok" response).

Note The instrument will always respond to the command "mode" with the status of the password lock as "mode local" or "mode remote", regardless of the above setting. ▲

The following example sets the instrument to accept the "set mode local" and "set mode remote" commands.

```
Send:         set allow mode cmd 1
Receive:      set allow mode cmd 1 ok
```

Table B–7. Allow Mode Command Values

Value	**Allow Mode Command**
0	Ignore (default)
1	Accept

---

baud

This command reports the current baud rate for the serial port (RS232/RS485). The following example reports that the current baud rate is 9600 baud.

```
Send:         baud
Receive:      baud 9600
```

set baud *rate*

rate = | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200 |

This command sets the instrument baud rate to *rate*. The following example sets the instrument's baud rate to 9600.

Note After the command is sent, the baud rate of the sending device must be changed to agree with the instrument. ▲

```
Send:         set baud 9600
Receive:      set baud 9600 ok
```

---

dhcp

This command reports the current state of use of the Dynamic Host Configuration Protocol (DHCP) as on or off. DHCP is used to assign an IP address to the instrument automatically. The following example shows that DHCP is on.

```
Send:         dhcp
Receive:      dhcp on
```

set dhcp *onoff*

onoff = | on | off |

This command enables (*on*) and disables (*off*) the DHCP service. When DHCP is set to on, the instrument gets the IP address, the netmask address, and the gateway address from a DHCP server. When DHCP is set to off, the instrument gets these addresses from system memory. The following example sets the DHCP service to on.

Note If DHCP is changed from on to off and then the IP address, the netmask address, or the gateway address is changed, you must cycle power to the instrument before the change takes effect. Until you cycle the power, the address assigned by the DHCP server will still be used and reported as the current address. ▲

```
Send:        set dhcp on
Receive:     set dhcp on ok
```

format

This command reports the current reply termination format. The following example shows that the reply format is 00, which means reply with no checksum, according to Table B–8.

```
Send:        format
Receive:     format 00
```

set format *format*

This command sets the reply termination *format*, where *format* is set according to Table B–8. The following example sets the reply termination format to checksum.

```
Send:        set format 01
Receive:     set format 01 ok
```

Table B–8. Reply Termination Formats

Format	**Reply Termination**
00	<CR>
01	<NL> sum xxxx <CR>

where xxxx = 4 hexadecimal digits that represent the sum of all the characters (bytes) in the message

host name

This command reports the host name string. The following example reports the host name is set to iSeries.

```
Send:        host name
Receive:     host name iSeries
```

set host name *string*

This command sets the host name *string*, where *string* is 1-13 alphanumeric characters. The following example sets the host name to analyzer01.

```
Send:        set host name analyzer01
Receive:     set host name analyzer01 ok
```

instr name

This command reports the instrument name. The following example reports the instrument name for the Model 5028*i*.

```
Send:       instr name
Receive:    instr name
            Beta
            Particle Analyzer
```

instrument id

This command reports the instrument identification (ID). The following example reports the current setting of the instrument ID.

```
Send:       instrument id
Receive:    instrument id 14
```

set instrument id *value*

This command sets the instrument ID to *value*, where *value* is an integer between 0 and 127 inclusive. The following example shows the instrument ID changed to 12.

Note Sending this command via RS-232 or RS-485 will require the host to use the new ID for subsequent commands. ▲

```
Send:       set instrument id 12
Receive:    set instrument id 12 ok
```

layout ack

This command reports the stale layout/layout change indicator (*) that is attached to each response if the erec layout has changed since the last time erec layout was requested, according to Table B–9. The following example reports that the instrument is configured to do nothing.

```
Send:       layout ack
Receive:    layout ack 0
```

set layout ack *value*

This command disables the stale layout/layout change indicator (*) that is attached to each response if the erec layout has changed since the last time erec layout was requested, according to Table B–9.

```
Send:       set layout ack
Receive:    set layout ack ok
```

Table B–9. Set Layout Ack Values

Value	Function
0	Do nothing (default)
1	Append "*"

power up mode

This command reports the current power up mode setting to either 0 = local/unlocked or 1 = remote/locked, according to Table B–10.The default value is 0; power up in local/unlocked mode. The following example shows that the instrument is configured to power up in the remote/locked mode.

```
Send:        power up mode
Receive:     power up mode 1
```

set power up mode *value*

This command is used to configure the instrument to power up in the local/unlocked mode (*value*= 0) or the remote/locked mode (*value* = 1), according to Table B–10.

If the instrument is set to power up in the local/remote mode, the keypad can be used to make changes via the front panel. If the instrument is set to power up in the remote/locked mode, changes can not be made from the front panel. The following example sets the instrument to power up in remote/locked mode.

```
Send:        set power up mode 1
Receive:     set power up mode 1 ok
```

Table B–10. Power Up Mode Values

Value	Power up Mode
0	Local/Unlocked Mode (default)
1	Remote/Locked Mode

program no

This command reports the analyzer's model information and program version number.

```
Send:        program no
Receive:     program no iSeries 5028i 00.05.37.093
```

tz

This command reports the "tz" timezone string for the NTP server. See "Network Time Protocol Server" in the "Communications Settings" section of the "Operation" chapter for more information.

```
Send:         tz
Receive:      tz EST+5EDT
```

set tz *string*
This command sets the timezone string for the instrument for use with the NTP server, where *string* is a standard timezone string. Common strings are listed in the "Timezone" screen description in Chapter 3.

```
Send:         set tz EST+5EDT
Receive:      set tz EST+5EDT ok
```

I/O Configuration

analog iout range *channel*
This command reports the analog current output range setting for *channel*, where *channel* must be between 1 and 6, inclusive. The following example reports current output channel 4 is in the 4-20 mA range, according to Table B–11. This command responds with "feature not enabled" if the I/O expansion board is not detected.

```
Send:         analog iout range 4
Receive:      analog iout range 4 2
```

set analog iout range *channel range*
This command sets analog current output *channel* to the *range* where *channel* is between 1 and 6 inclusive, and *range* is set according to Table B–11. The following example sets current output channel 4 to the 0-20 mA range. This command responds with "feature not enabled" if the I/O expansion board is not detected.

```
Send:         set analog iout range 4 1
Receive:      set analog iout range 4 1 ok
```

Table B–11. Analog Current Output Range Values

Range	**Output Range**
1	0-20 mA
2	4-20 mA
0 [cannot be set to this, but may report]	Undefined

analog vin *channel*
This command retrieves the analog voltage input *channel* data, both the calculated value and the actual voltage. In the following example, the "calculated" value of channel 1 is 75.325 degrees F, volts are 2.796. This command responds with "feature not enabled" if the I/O expansion board is not detected.

```
Send:         analog vin 1
Receive:      analog vin 1 75.325, 2.796 V
```

analog vout range *channel*

This command reports the analog voltage output *channel* range, where channel is between 1 and 6 inclusive, according to Table B–12. The following example reports that analog voltage output channel 2 is set to 3 (0-10 V).

```
Send:         analog vout range 2
Receive:      analog vout range 2 3
```

set analog vout range *channel range*

This command sets analog voltage output *channel* to the *range*, where *channel* is between 1 and 6 inclusive, and *range* is set according to Table B–12. The following example sets channel 2 to the 0-10 V range.

```
Send:         set analog vout range 2 3
Receive:      set analog vout range 2 3 ok
```

Table B–12. Analog Voltage Output Range Values

Range	**Output Range**
1	0-1 V
2	0-100 mV
3	0-10 V
4	0-5 V
0 [cannot be set to this, but may report]	Undefined

dig in

This command reports the status of the digital inputs as a 4-digit hexadecimal string with the most significant bit (MSB) being input 16.

```
Send:         dig in
Receive:      dig in 0xffff
```

din *channel*

This command reports the action assigned to the digital input *channel* and the index number of the corresponding active state. The following example reports input 1 to be assigned an index number 3 corresponding to action of “PM mode” with the active state being high.

```
Send:         din 1
Receive:      din 1 3 PM MODE high
```

set din *channel index state*
This command assigns digital input *channel* (1-16) to activate the action indicated by *index* (1-12), when the input transitions to the designated *state* (high or low). Use the "list var din" command to obtain the list of supported *index* values and corresponding actions. The following example sets the digital input channel 1 to 3 on a low-to-high transition.

```
Send:          set din 1 3 high
Receive:       set din 1 3 high ok
```

---

dout *channel*
This command reports the index number, output variable and the active state assigned to digital output *channel*. The following example reports output 4 to be assigned an index number 11 corresponding to action of "flowl alarms".

```
Send:          dout 4
Receive:       dout 4 11 FLOW ALARMS open
```

set dout *channel index state*
This command assigns digital output *channel* to be assigned to the action associated with *index*, and assigns it an active state of *state* (open or closed). Use the "list var dout" command to obtain the list of supported index values and corresponding state. The following example sets the digital output channel 4 to state 11.

```
Send:          set dout 4 11 open
Receive:       set dout 4 11 open ok
```

---

dtoa *channel*
This command reports the outputs of the 6 or 12 Digital to Analog converters, according to Table B–13. The following example shows that the D/A #1 is 97.7% full-scale.

```
Send:          dtoa 1
Receive:       dtoa 1 97.7%
```

Note If the instrument is in a mode which does not provide a particular output, and that output is selected, the value will be 0.0. ▲

All channel ranges are user definable. If any customization has been made to the analog output configuration, the default selections may not apply. ▲

Table B–13. Default Analog Output Channel Assignments

D to A	Function	Range
1	Voltage Output	PM
2	Voltage Output	AVG PM
3	Voltage Output	Flow
4	Voltage Output	Ambient Temperature
5	Voltage Output	Flow Temperature
6	Voltage Output	Ambient Relative Humidity
7	Current Output	PM
8	Current Output	AVG PM
9	Current Output	Flow
10	Current Output	Ambient Temperature
11	Current Output	Flow Temperature
12	Current Output	Ambient Relative Humidity

list din
list dout

These commands report the current selection for the digital inputs or the digital outputs in the format. Output no Index number variable name active state. The active state for digital outputs is open or closed. The active state for digital inputs is high or low.

```
Send:         list dout
Receive:      list dout
              output index variable state
               1  5 CONC ALARM open
               2  1 LOCAL/REMOTE open
               3  3 UNITS open
```

list var aout
list var dout
list var din
list var log

These commands report the list of possible index numbers, and the variables (associated with that index number) available for selection in the current mode for analog outputs, digital outputs, digital inputs and datalogging. The index number is used to insert the variable in a field location in a list using "set sp *field index*". The following example reports the list of analog outputs, index numbers, and variables.

```
Send:         list var aout
Receive:      list var aout
              index variable
               0 none
```

```
 1 pm
 3 baro
 4 vac
 6 pflow
 8 ambrt
 9 srh
11 ambtemp
12 brdtemp
13 ftemp
15 stemp
17 frol
19 beta
28 braw
29 araw
30 avgpm
32 mass
34 bzero
45 exfg
50 bref
52 cflg
53 aflg
```

relay stat

This command reports the current relay logic as normally "open" or normally "closed," if all the relays are set to same state, that is all open or all closed. The following example shows that the status of all the relays' logic is set to normally "open".

```
Send:        relay stat
Receive:     relay stat open
```

Note If individual relays have been assigned different logic, then the response would be a 4-digit hexadecimal string with the least significant byte (LSB) being relay no 1. ▲

For example:

```
Receive:     relay stat 0x0001
```

(indicates relay no 1 is set to normally open logic, all others are normally closed)

```
Receive:     relay stat 0x0005
```

(indicates relay no 1 and 3 are set to be normally open logic, all others are normally closed)

set relay open
set relay open *value*
set relay closed
set relay closed *value*

These commands set the relay logic to normally open or closed for relay number *value*, where *value* is the relay between 1 and 16. The following example sets the relay no 1 logic to normally open.

Note If the command is sent without an appended relay number, then all the relays are assigned the set logic of normally open/closed. ▲

```
Send:        set relay open 1
Receive:     set relay open 1 ok
```

Record Layout Definition

The erec, lrec, and srec layouts contain the following:

- A format specifier for parsing ASCII responses
- A format specifier for parsing binary responses

In addition to these, the erec layout contains:

- A format specifier for producing the front panel display screens

Values are read using either the ASCII or binary format specifiers and converted to uniform internal representations (32-bit floats or 32-bit integers). These values are converted into text for display on the screen using the format specifier for the front panel display. Normally, the specifier used to parse a particular datum from the input stream will be strongly related to the specifier used to display it (such as, all of the floating point inputs will be displayed with an 'f' output specifier, and all of the integer inputs will be displayed with a 'd' specifier).

Format Specifier for ASCII Responses

The first line of the layout response is the scanf-like parameter list for parsing the fields from an ASCII erec response. Parameters are separated by spaces and the line is terminated by a "\n" (the normal line separator character). Valid fields are:

%s - parse a string
%d - parse a decimal number
%ld - parse a long (32-bit) decimal number
%f - parse a floating point number
%x - parse a hexadecimal number
%lx - parse a long (32-bit) hex number
%* - ignore the field

Note Signed versus unsigned for the integer values does not matter; it is handled automatically. ▲

Format Specifier for Binary Responses

The second line of the layout response is the binary parameter list for parsing the fields from a binary response. Parameters MUST be separated by spaces, and the line is terminated by a '\n'. Valid fields are:

t - parse a time specifier (2 bytes)
D - parse a date specifier (3 bytes)
i - ignore one 8-bit character (1 byte)
e - parse a 24-bit floating point number (3 bytes: n/x)
E - parse a 24-bit floating point number (3 bytes: N/x)

f - parse a 32-bit floating point number (4 bytes)

c - parse an 8-bit signed number (1 byte)
C - parse an 8-bit unsigned number (1 byte)
n - parse a 16-bit signed number (2 bytes)
N - parse a 16-bit unsigned number (2 bytes)
m - parse a 24-bit signed number (3 bytes)
M - parse a 24-bit unsigned number (3 bytes)
l - parse a 32-bit signed number (4 bytes)
L - parse a 32-bit unsigned number (4 bytes)

There is an optional single digit d which may follow any of the numeric fields, which indicates that after the field has been parsed out, the resulting value is to be divided by 10^d. Thus the 16-bit field 0xFFC6 would be interpreted with the format specifier 'n3' as the number -0.058.

Format Specifier for Erec Layout

The subsequent lines in the erec layout response describe the appearance of the full panel. The full instrument panel as it appears on the screen has two columns of lines. Each line is composed of three major components: (1) a text field, (2) a value field, and (3) a button. None of these three components is required. The text field contains statically displayed text.

The value field displays values which are parsed out of the response to a erec command. It also displays, though background changes, alarm status. The button, when pressed, triggers input from either a dialog box or a selection list. There are five kinds of buttons, B, I, L, T, and N.

Each line in the layout string corresponds to one line on the display. The layout string describes each of the three major fields as well as translation mechanisms and corresponding commands.

Text

The first field in the layout string is the text. It is delimited by a ':'. The string up to the first ':' will be read and inserted in the text field of the line.

Value String

This is followed by a possible string enclosed in quotes that is used to place a string into the value field.

Value Source

The value source, which is the item (or word) number in the DATA/EREC response, appears next. This is followed by an optional bitfield designator. The datum identified by the value source can be printed as a string 's', hexadecimal 'x', decimal 'd', floating point 'f', or binary 'b' number. Typically, bitfield extractions are only done for decimal or hexadecimal numbers.

Floating-point numbers can be followed with an optional precision specifier which will be used as an argument to printf's %f format (for example, a field of '4' would be translated into the printf command of '%.3f'). Alternately, the special character '*' can precede the precision specifier; this causes an indirection on the precision specifier (which now becomes a field number).

This is useful when formatting, for example, numbers which have varying precision depending on the mode of the instrument.

Binary numbers can also have an optional precision specifier which is used to determine how many bits to print. For example, the specifier 'b4' will print the lowest four bits of the parsed number.

There are serious restrictions on where an 's' field may appear: currently sources 1 and 2 must be 's', and no others may be 's'.

Alarm Information

The value source is followed by optional alarm information, indicated by a commercial at sign '@' with a source indicator and a starting bit indicator. All alarm information is presumed to be two bits long (low and high). The bitfield extraction is performed on the integer part of the source. Typical alarm information would appear as '@6.4'.

Translation Table

Then, there appears an optional translation table within braces '{}'. This is a string of words separated by spaces. An example translation table would be '{Code_0 Code_1 Code_2 Code_3}'. The value, once extracted, is used as a zero-based index into the translation table to determine the string to display.

Selection Table

Then there appears an optional selection table within parentheses '(...)'. This is a string of numbers separated by spaces '(0 1)'. The selection table lists the translation table entries which the user may select from when setting the parameter. This is not necessarily the same as the entries which may be displayed.

Button Designator

Then there appears an optional button designator. This will be one of 'B', 'I', 'L', 'T', or 'N'.

B- Indicates a button which pops up an input dialog prompting the user for a new value using the designated input format. The input format is specified from the 'B' through the subsequent semicolon.

I—Indicates a button which pops up a selection list with input translation. That is, the values read are translated before they are compared to the selection list options.

L—Indicates a button which pops up a selection list without any translation. The output value is the number of the selected option.

T—Indicates a button which pops up a selection list with output translation. The number of the option selected is used as an index into the translation table to generate an output string.

N—Indicates a button which only sends the subsequent command to the instrument. No user-prompting happens.

The following string through an optional '|' or the end of the line is the command which is to be sent to the instrument upon the completion of the button selection. The command string should normally contain print-style formatting to include the user input. If a '|' is present, it indicates a command which is sent to the instrument upon successful completion of the button command to update the value field.

Examples

Some examples ('\n' is the C syntax for an end-of-line character):

```
'Concentrations\n'
```

This is a single text-only line.

```
'\n'
```

This is a single blank line.

```
' NO:3s\n'
```

This is a line which appears slightly indented. The text field is 'NO', the value is taken from the third element of the data response, and interpreted as a string.

```
' NO:18sBd.ddd;set no coef %s\n'
```

This is a line which also appears slightly indented. The next field is also 'NO', but the value is taken from the eighteenth element of the data response, again interpreted as a string. A button appears on this line which, when pressed, pops up an input dialog which will state "Please enter a new value for NO using a d.ddd format." The string entered by the user is used to construct the output command. If the user enters, for example, '1.234', the constructed command will be 'set no coef 1.234'.

```
' NO:21f{Code_0 Code_1 Code_2 Code_3 Code_4 Code_5 Code_6 Code_7 Code_8 Code_9 Code_10 Code_11}Lset range no %d\n'
```

This is a line which appears slightly indented, the title is again 'NO', and the value is the twenty-first element of the data response, interpreted as a floating-point number. There is a no-translation button which creates a selection list of twelve "Code nn" options. The number of the user selection is used to create the output command.

```
'Mode:6.12-13x{local remote service service}(0 1)Tset mode %s\n'
```

This is a line which has a title of 'Mode' and value taken from the sixth field of the data response. There is a bitfield extraction of bits 12 through 13 from the source (the value type is not important here because the value is being translated to an output string). Once the bits have been extracted, they are shifted down to the bit-zero position. Thus, the possible values of this example will be 0 through 3. The translation list shows the words which correspond to each input value, the zero index value appearing first (0 -> local, 1 -> remote, etc.). The selection list shows that only the first two values, in this case, are to be shown to the user when the button is pressed. The 'T' button indicates full translation, input code to string, and user selection number to output string.

```
'\xC'
```

This is a line that starts a new column (the \xC or ^L).

```
' Comp:6.11x{off on}Tset temp comp %s\n'
```

This shows that the bitfield end (the second part of a bitfield specification) is optional. The bitfield will be one bit long, starting in this case at the eleventh bit.

```
'Background:7f*8Bd.ddd;set o3 bkg %s\n'
```

This shows the use of indirect precision specifiers for floating point displays. The background value is taken from the 7th element, and the precision specifier is taken from the 8th. If the asterisk were not present, it would indicate instead that 8 digits after the decimal point should be displayed.

Appendix C
MODBUS Protocol

This appendix provides a description of the MODBUS Protocol Interface and is supported both over RS-232/485 (RTU protocol) as well as TCP/IP over Ethernet.

The MODBUS commands that are implemented are explained in detail in this document. The MODBUS protocol support for the iSeries enables the user to perform the functions of reading the various concentrations and other measurement values, read the status of the digital outputs of the analyzer, and to trigger or simulate the activation of a digital input to the instrument. This is achieved by using the supported MODBUS parameters listed below.

Up to three simultaneous connections are supported over Ethernet.

For details of the Model 5028*i* MODBUS Protocol specification, see the following topics:

- "Serial Communication Parameters" on page C-1
- "TCP Communication Parameters" on page C-2
- "Application Data Unit Definition" on page C-2
- "Function Codes" on page C-3
- "MODBUS Parameters Supported" on page C-8

Additional information on the MODBUS protocol can be obtained at http://www.modbus.org. References are from MODBUS Application Protocol Specification V1.1a MODBUS-IDA June 4, 2004.

Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the iSeries to support MODBUS RTU protocol.

Number of Data bits	: 7 or 8
Number of Stop bits	: 1 or 2
Parity	: None, Odd, or Even
Data rate	: 1200 to 115200 Baud (9600 is default)

TCP Communication Parameters

*i*Series instruments support the MODBUS/TCP protocol. The register definition is the same as for the serial interface. Up to three simultaneous connections are supported over Ethernet.

TCP connection port for MODBUS : 502

Application Data Unit Definition

Here are the MODBUS ADU (Application Data Unit) formats over serial and TCP/IP:

Serial:	Slave Address	Function Code	Data	Error Check
TCP/IP:	MBAP Header	Function Code	Data	

Slave Address

The MODBUS slave address is a single byte in length. This is the same as the instrument ID used for C-Link commands and can be between 1 and 127 decimal (i.e. 0x01 hex to 0x7F hex). This address is only used for MODBUS RTU over serial connections.

Note Device ID '0', used for broadcast MODBUS commands, is not supported. Device IDs 128 through 247 (i.e. 0x80 hex to 0xF7 hex) are not supported because of limitations imposed by C-Link. ▲

MBAP Header

In MODBUS over TCP/IP, a MODBUS Application Protocol Header (MBAP) is used to identify the message. This header consists of the following components:

Transaction Identifier	2 Bytes	0x0000 to 0xFFFF (Passed back in response)
Protocol Identifier	2 Bytes	0x00 (MODBUS protocol)
Length	2 Bytes	0x0000 to 0xFFFF (Number of following bytes)
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

A slave address is not required in MODBUS over TCP/IP because the higher-level protocols include device addressing. The unit identifier is not used by the instrument.

Function Code

The function code is a single byte in length. The following function codes are supported by the instrument:

Read Coils	:	0x01
Read Inputs	:	0x02
Read Holding Registers	:	0x03
Read Input Registers	:	0x04
Force (Write) Single Coil	:	0x05
Read Exception Status	:	0x06

If a function code is received that is not in this list, an invalid function exception is returned.

Data

The data field varies depending on the function. For more description of these data fields, see "Function Codes" below.

Error Check

In MODBUS over serial, an error check is included in the message. This is not necessary in MODBUS over TCP/IP because the higher-level protocols ensure error-free transmission. The error check is a two-byte (16 bit) CRC value.

Function Codes

This section describes the various function codes that are supported by the Model 5028*i*.

(0x01/0x02) Read Coils/ Read Inputs

Read Coils/Inputs read the status of the digital outputs (relays) in the instrument. Issuing either of these function codes will generate the same response.

These requests specify the starting address, i.e. the address of the first output specified, and the number of outputs. The outputs are addressed starting at zero. Therefore, outputs numbered 1–16 are addressed as 0–15.

The outputs in the response message are packed as one per bit of the data field. Status is indicated as 1 = Active (on) and 0 = Inactive (off). The LSB of the first data byte contains the output addressed in the query. The other outputs follow toward the high end of this byte, and from low order to high order in subsequent bytes. If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Note The values reported may not reflect the state of the actual relays in the instrument, as the user may program these outputs for either active closed or open. ▲

Request

Function Code	1 Byte	0x01 or 0x02
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of Outputs	2 Bytes	1 to maximum allowed by instrument
Unit Identifier	1 Byte	0x00 to 0xFF (Passed back in response)

Response

Function Code	1 Byte	0x01 or 0x02
Byte Count	1 Byte	N*
Output Status	N Byte	N = N or N+1

*N = Quantity of Outputs / 8, if the remainder not equal to zero, then N=N+1

Error Response

Function Code	1 Byte	0x01 or 0x02
Exception Code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request and response to read outputs 2–15:

Request

Field Name	*(Hex)*
Function	0x01
Starting Address Hi	0x00
Starting Address Lo	0x02
Quantity of Outputs Hi	0x00
Quantity of Outputs Lo	0x0D

Response

Field Name	*(Hex)*
Function	0x01
Byte Count	0x03
Output Status 2–10	0xCD
Output Status 11–15	0x0A

The status of outputs 2–10 is shown as the byte value 0xCD, or binary 1100 1101. Output 10 is the MSB of this byte, and output 2 is the LSB. By convention, bits within a byte are shown with the MSB to the left and the LSB to the right. Thus, the outputs in the first byte are '10 through 2', from left to right. In the last data byte, the status of outputs 15-11 is shown as the byte value 0x0A, or binary 0000 1010. Output 15 is in the fifth bit position from the left, and output 11 is the LSB of this byte. The four remaining high order bits are zero filled.

(0x03/0x04) Read Holding Registers/Read Input Registers

Read Holding/Input Registers reads the measurement data from the instrument. Issuing either of these function codes will generate the same response. These functions read the contents of one or more contiguous registers.

These registers are 16 bits each and are organized as shown below. All of the values are reported as 32-bit IEEE standard 754 floating point format. This uses 2 sequential registers, least significant 16 bits first.

The request specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore, registers numbered 1–16 are addressed as 0–15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function Code	1 Byte	0x03 or 0x04
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Quantity of Registers	2 Bytes	1 to maximum allowed by instrument

Response

Function Code	1 Byte	0x03 or 0x04
Byte Count	1 Byte	2 x N*
Register Value	N* x 2 Bytes	N = N or N+1

*N = Quantity of Registers

Error Response

Function Code	1 Byte	Function code + 0x80
Exception Code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request and response to read registers 10–13:

Request

Field Name	*(Hex)*
Function	0x03
Starting Address Hi	0x00
Starting Address Lo	0x09
No. of Registers Hi	0x00
No. of Registers Lo	0x04

Response

Field Name	*(Hex)*
Function	0x03
Byte Count	0x06
Register Value Hi (10)	0x02
Register Value Lo (10)	0x2B
Register Value Hi (11)	0x00
Register Value Lo (11)	0x00
Register Value Hi (12)	0x00
Register Value Lo (12)	0x64
Register Value Hi (13)	0x00
Register Value Lo (13)	0x64

The contents of register 10 are shown as the two byte values of 0x02 0x2B. Then contents of registers 11–13 are 0x00 0x00, 0x00 0x64 and 0x00 0x64, respectively.

(0x05) Force (Write) Single Coil

The Force (Write) Single Coil function simulates the activation of the digital inputs in the instrument, which triggers the respective action.

This function code is used to set a single action to either ON or OFF. The request specifies the address of the action to be forced. Actions are addressed starting at zero. Therefore, action number 1 is addressed as 0. The requested ON/OFF state is specified by a constant in the request data field. A value of 0xFF00 requests the action to be ON. A value of 0x0000 requests it to be OFF. All other values are illegal and will not affect the output. The normal response is an echo of the request, returned after the state has been written.

Note This function will not work if the instrument is in service mode. ▲

Request

Function Code	1 Byte	0x05
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

Response

Function Code	1 Byte	0x05
Starting Address	2 Bytes	0x0000 to maximum allowed by instrument
Output Value	2 Bytes	0x0000 or 0xFF00

Error Response

Function Code	1 Byte	Function code + 0x80
Exception Code	1 Byte	01=Illegal Function, 02=Illegal Address, 03=Illegal Data, 04=Slave Device Failure

Here is an example of a request to write Coil 5 ON:

Request

Field Name	*(Hex)*
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

Response

Field Name	*(Hex)*
Function	05
Output Address Hi	00
Output Address Lo	05
Output Value Hi	FF
Output Value Lo	00

MODBUS Parameters Supported

Table C–1 through Table C–3 lists the MODBUS addresses supported for the Model 5028*i*.

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the coil number on your MODBUS master to ensure that it matches the coil number on the instrument. ▲

Note Coil status 1 indicates active state. ▲

Table C–1. Read Coils for 5028*i*

Coil Number	Status
0	INVALID
1	LOCAL/REMOTE
2	SERVICE
3	[NOT USED]
4	[NOT USED]
5	CONC ALARM
6	INST ALARMS
7	DET ALARMS
8	NEPH ALARMS

Coil Number	Status
9	RH/TEMP ALARMS
10	PRES/VAC ALARMS
11	FLOW ALARMS
12	[NOT USED]
13	[NOT USED]
14	[NOT USED]
15	EXT ALARM 1
16	EXT ALARM 2
17	EXT ALARM 3
18	FILTER TAPE CNT a ALARMS
19	FILTER TAPE OK a ALARMS
20	BETA A ALARMS
21	NEPH SAMPLE ALARAMS
22	NEPH TEMP A ALARMS
23	NEPH RH A ALARMS
24	AMB RH ALARMS
25	SAMPLE RH ALARMS
26	TEMP AMB ALARMS
27	TEMP FLOW A ALARMS
28	PRES BAR ALARMS
29	PRES VAC A ALARMS
30	FLOW VOL A ALARMS
31	INST CONC SHARP a ALARMS
32	INST CONC NEPH a ALARMS
33	FLAG SET 3
34	FLAG SET 2
35	FILTER TAPE CNT b ALARMS
36	FILTER TAPE OK b ALARMS
37	BETA B ALARMS
38	TEMP FLOW b
39	PRES VAC b ALARMS
40	FLOW VOL b ALARMS

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the register number on your MODBUS master to ensure that it matches the register number on the instrument. ▲

Note For additional information on how to read registers and interpret the data, refer to the "(0x03/0x04) Read Holding Registers/Read Input Registers" section in this appendix. ▲

Table C–2. Read Registers for 5028*i*

Register Number	Variable
0	INVALID
1 & 2	PMa
3 & 4	PMb
5 & 6	BARO PRES
7 & 8	VACUUM a
9 & 10	VACUUM b
11 & 12	FLOW PRES a
13 & 14	FLOW PRES b
15 & 16	AMB RH
17 & 18	SAMP RH a
19 & 20	SAMP RH b
21 & 22	AMB TEMP
23 & 24	BRD TEMP
25 & 26	FLOW TEMP a
27 & 28	FLOW TEMP b
29 & 30	FLOW VOL a
31 & 32	FLOW VOL b
33 & 34	BETA a
35 & 36	ANALOG IN 1
37 & 38	ANALOG IN 2
39 & 40	ANALOG IN 3
41 & 42	ANALOG IN 4
43 & 44	ANALOG IN 5
45 & 46	ANALOG IN 6
47 & 48	ANALOG IN 7
49 & 50	ANALOG IN 8
51 & 52	BETA RAW a
53 & 54	ALPHA RAW a
55 & 56	AVG PM a
57 & 58	AVG PM b
59 & 60	MASS a

Register Number	Variable
61 & 62	MASS b
63 & 64	BETA ZERO a
65 & 66	BETA ZERO b
67 & 68	BETA b
69 & 70	BETA RAW b
71 & 72	NEPH
73 & 74	EXT ALARMS
75 & 76	BETA REF
77 & 78	BETA REF b
79 & 80	COMMON FLAGS
81 & 82	ALPHA FLAGS
83 & 84	BETA DETECTOR FLAGS
85 & 86	COMP MASS a
87 & 88	COMP MASS b
89 & 90	HIGH VOLT

IMPORTANT NOTE The addresses in the following tables are Protocol Data Unit (PDU) addresses. Verify the coil number on your MODBUS master to ensure that it matches the coil number on the instrument. ▲

Note Writing 1 to the coil number shown in the following table will initiate the "action triggered" listed in the table. This state must be held for at least 1 second to ensure the instrument detects the change and triggers the appropriate action. ▲

Note The coils within each coil group in the following table are mutually exclusive and will not be triggered if there is conflict. Before you assert (1) one coil in a group, make sure the other coils in the group are de-asserted (0). ▲

Table C–3. Write Coils for 5028*i*

Coil Number	Action Triggered
100	INVALID
101	MODE a
102	MODE b
103	MODE ab
104	AOUTS TO ZERO
105	AOUTS TO FS

Coil Number	Action Triggered
106	FT RESET a
107	FT TAPE CTRL a
108	PUMP CNTRL ON/OFF
109	TEMP COMP ON/OFF
110	PRES COMP ON/OFF
111	HEATER a ON/OFF
112	HTR RH/TEMP a CNTRL
113	HEATER b ON/OFF
114	HTR RH/TEMP b CNTRL
115	EXT ALARM 1
116	EXT ALARM 2
117	EXT ALARM 3
118	FT RESET b
119	FT TAPE CTRL b

Appendix D
Gesytec (Bayern-Hessen) Protocol

This appendix provides a description of the Gesytec (Bayern-Hessen or BH) Protocol Interface and is supported both over RS-232/485 as well as TCP/IP over Ethernet.

The Gesytec commands that are implemented are explained in detail in this document. The Gesytec protocol support for the iSeries enables the user to perform the functions of reading the various concentrations and to trigger the instrument to be in sample/zero/span mode if valid for that instrument. This is achieved by using the supported Gesytec commands listed below.

Up to three simultaneous connections are supported over Ethernet.

For details of the Model 5028*i* Gesytec Protocol specification, see the following topics:

Serial Communication Parameters

The following are the communication parameters that are used to configure the serial port of the iSeries to support Gesytec protocol.

Number of Data bits	: 7 or 8
Number of Stop bits	: 1 or 2
Parity	: None, Odd, or Even
Data rate	: 1200 to 115200 Baud (9600 is default)

TCP Communication Parameters

*i*Series instruments support the Gesytec protocol over TCP/IP. The register definition is the same as for the serial interface. Up to three simultaneous connections are supported over Ethernet.

TCP connection port for Gesytec: 9882

Instrument Address

The Gesytec instrument address has a value between 0 and 127 and is represented by a 3 digit ASCII number with leading zeros or leading spaces if required (e.g. instrument address of 1 is represented as 001 or <SP><SP>1). The default instrument address is 14.

The instrument address is the same as the Instrument ID used for C-Link and MODBUS commands. This can be set via the front panel.

The instrument address is represented by <address> in the examples throughout this document.

Note Device IDs 128 through 247 are not supported because of limitations imposed by the C-Link protocol. ▲

Abbreviations Used

The following is a list of abbreviations used in this document:

<CR> is abbreviation for Carriage Return (ASCII code 0x0D)

<STX> is abbreviation for Start of Text (ASCII code 0x02)

<ETX> is abbreviation for End of Text (ASCII code 0x03)

<SP> is abbreviation for space (ASCII code 0x20)

Basic Command Structure

The following is the basic structure of a Gesytec command:

<STX>Command text<ETX><BCC>

OR

<STX>Command text<CR>

Each command is framed by control characters, <STX> at the start and terminated with either <ETX> or <CR>.

If a command is terminated with <ETX>, then two additional characters <BCC> is attached after <ETX>. This is the block checksum.

Block Checksum Characters <BCC> may be added to the command to prevent processing invalid commands.

Block Checksum Characters <BCC>

The Block Checksum Characters are calculated beginning with a seed value of 00000000, binary (0x00), and bitwise exclusive ORing with each of the characters of the command string (or response) including the framing characters <STX> and <ETX>. The checksum works as an error check. The command terminator determines the presence or absence of <BCC>.

If a command is terminated by <ETX> then the next two characters are the checksum, if the command is terminated with <CR> no checksum is attached.

The block checksum is represented by two characters, which represent a 2 digit hex number (1byte) (e.g. 1 byte 0xAB hex checksum will be represented by the two characters 'A' & 'B').

The checksum is referred to as <BCC> throughout this document.

Gesytec Commands

The following commands are supported by the Gesytec protocol:

- Instrument Control Command (ST)
- Data Sampling/Data Query Command (DA)

Instrument Control Command (ST)

There is one control command supported by the Gesytec protocol.

This <control command> is a single letter, which triggers an action in the instrument. These commands are active only when service mode is inactive and the zero/span option is present.

Command 'N' initiates a filter change.

The following are the different acceptable formats of the ST command:

<STX>ST<address><control command><ETX><BCC>

OR

<STX>ST<address><control command><CR>

OR

<STX>ST<address><SP><control command><CR>

OR

<STX>ST<address><SP><control command><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address>, if present, must match the Instrument Address. Additional space can be present after the <address>.

If the received command does not satisfy the above formats, or if the <address> does not match the Instrument Address, the command is ignored.

This is a sample command to switch the instrument to initiate a filter change, instrument address 14:

`<STX>ST014<SP>N<CR>`

Data Sampling/Data Query Command (DA)

This command initiates a data transfer from the instrument. The instrument responds with measurement data, which depends on the range mode and is listed in "Measurements reported in response to DA command" below.

The command structure for a data query command is as follows:

<STX>DA<address><ETX><BCC>

The <address> is optional, which means it can be left out completely. The <address>, if present, must match the Instrument Address. Additional space can be present after the <address>.

If the <address> is left out, then no space is allowed in the query string.

A command with no address is also a valid command.

The following are the different acceptable formats of the DA command with Instrument Address 14:

<STX>DA<CR>

<STX>DA014<CR>

<STX>DA<SP><14<ETX><BCC>

<STX>DA<ETX><BCC>

The data query string is valid and will be answered with data transmission only if the command starts with <STX>, which is followed by the characters DA, and the <address> (if present) matches the Instrument Address, and the command is terminated with either <CR> with no checksum or <ETX>, followed by the correct checksum <BCC>.

Sample Data Reply String in response to Data Query Command (DA):

In response to a valid data query command, the instrument responds in the following format:

<STX>MD09<SP><address><SP><measured value1><SP><status><SP><SFKT><SP><address+1><SP><measured value2><SP ><status><SP><SFKT><ETX><BCC>

The response uses the same command terminators as used by the received command, i.e. if the received command was terminated with a <CR> then the response is terminated with <CR>, and if the command was terminated with a <ETX><BCC>, then the response is terminated with<ETX> and the computed checksum <BCC>.

The 09 after the MD indicates that nine measurements are present in the reply string, 10 for ten measurements and so on. This will also determine the length of the reply string.

<address> is the Instrument Address. Each subsequent measurement attached to the response will have the <address + X>, where X keeps incrementing by 1 for each measurement included.

<measured value> is the concentration value in currently selected gas units, represented as exponential representation with 4 characters mantissa and 2 characters exponent, each with sign.

Mantissa: sign and 4 digits. The decimal point is assumed to be after the first digit and is not transmitted.

Exponent: sign and 2 digits.

Example:

-5384000.0 is represented as -5384+06

+0.04567 is represented as +4567-02

<status>: is formed by < operating status > and < error status > and separated by a space, i.e.:

<operating status><SP><error status>

Each of the two (<operating status> and <error status>) are formed by two characters, each representing a 2 digit hex number which is one byte (8 Bits) operation status and one byte (8 Bits) error status.

These two bytes contain the information about the main operating conditions of the instrument at that instant. For details on how to interpret the status bytes, refer to Table D–1 and Table D–2 below.

<SFKT>: is the space provided for future use for special function. It currently contains a string of ten 0's, i.e. <0000000000>.

The Gesytec serial number defaults to zero. To set the Gesytec serial number select Main Menu > Instrument Controls > Communication Settings > **Gesytec Serial No**.

Example of response to DA command from an instrument with Gesytec serial number set to 000. The Gesytec serial number is **bold** in the example.

Gesytec Protocol with transmission of three concentrations (Instrument ID is 1, Operation Status is 03, Error Status is 04):

Data Query String: `<STX>DA<CR>`

Reply String:

```
<STX>MD03<SP>001<SP>+2578+01<SP>03 <SP>04<SP>0000000000 <SP>002 <SP>
```

Address First Concentration(E-format)=25.78 Address+1

```
+5681+00<SP>03<SP>04<SP>0000000000<SP>003<SP>+1175+01<SP>03<SP>04<SP
```

Second Concentration = 5.681 Address+2 Third Concentration=11.75

```
0000000000<SP><CR>
```

Example of response to DA command from an instrument with Gesytec serial number set to 123. The Gesytec serial number is **bold** in the example.

Gesytec Protocol with transmission of three concentrations (Instrument ID is 1, Operation Status is 03, Error Status is 04):

Data Query String: `<STX>DA<CR>`

Reply String:

```
<STX>MD03<SP>001<SP>+2578+01<SP>03 <SP>04<SP>1230000000 <SP>002 <SP>
```

Address First Concentration(E-format)=25.78 Address+1

```
+5681+00<SP>03<SP>04<SP>0000000000<SP>003<SP>+1175+01<SP>03<SP>04<SP
```

Second Concentration = 5.681 Address+2 Third Concentration=11.75

```
1230000000<SP><CR>
```

The attached concentrations are in the selected gas units. The measurements that are attached to the response, if not valid in a particular mode, will report a value of 0.0.

Measurements reported in response to DA command

The following 9 measurements reported in response to DA command for the Model 5028*i* include:

- PM
- Mass
- Volumetric Flow
- Ambient Temperature
- Flow Temperature
- Ambient RH
- Flow Pressure
- Vacuum Pressure
- Barometric Pressure

Operating and Error Status

See Table D–1 for operating status and Table D–2 for error status for the Model 5028*i*.

Table D–1. Operating Status for Model 5028*i*

	D7	D6	D5	D4	D3	D2	D1	D0
→ Bit	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
→ Hex-value	80	40	20	10	08	04	02	01
	MSB				LSB			
Operating status:								
Service Mode (On)	0	0	0	0	0	0	0	1
Maintenance (Local)	0	0	0	0	0	0	1	0
Pump (Off)	0	0	0	0	0	1	0	0
Heater (Off)	0	0	0	0	1	0	0	0
Filter Change	0	0	0	1	0	0	0	0
Not Used	0	0	1	0	0	0	0	0
Not Used	0	1	0	0	0	0	0	0
Not Used	1	0	0	0	0	0	0	0

Table D–2. Error Status for Model 5028*i*

	D7	D6	D5	D4		D3	D2	D1	D0
→ Bit	**8**	**7**	**6**	**5**		**4**	**3**	**2**	**1**
→ Hex-value	80	40	20	10		08	04	02	01
	MSB					LSB			
Error status:									
Filter Counter	0	0	0	0		0	0	0	1
Filter Change	0	0	0	0		0	0	1	0
Beta Detector Alarm	0	0	0	0		0	1	0	0
Not Used	0	0	0	0		1	0	0	0
Detector Board Status Alarm	0	0	0	1		0	0	0	0
Motherboard Status Alarm	0	0	1	0		0	0	0	0
Flow Alarm	0	1	0	0		0	0	0	0
Not Used	1	0	0	0		0	0	0	0

Appendix E
ESM Protocol Commands

This appendix provides a description of the ESM Protocol commands (from the prior FH62 platform) that can be used to remotely control a Model 5028*i* instrument using a host device such as a PC or a datalogger. ESM protocol may be used over RS-232, RS-485 or over Ethernet. ESM functions can be accessed over Ethernet using TCP port 9884.

Up to three simultaneous connections per protocol may be made over Ethernet.

ESM Commands Supported

Table E-1 through E-3 lists the ESM commands supported for the Model 5028*i*.

Table E–1. Read Commands for 5028*i*

Command	Description
C	output of the dust mass concentration in µg/m³ (actual mode)
HT	24 h (daily) average concentration [µg/m³]
JB	temperature sampling head
JC	temperature dust sampling chamber
JD	temperature inside of the flow meter orifice
JF	different pressure of the air flow measuring module in Pa
JG	low pressure suction chamber
JH	barometer in hPa
JI	air flow sampling head
JJ	norm air flow (273K, 1013hPa)
JO	air flow rate regulation 0…100%
JR	relative humidity value (%RH)
JS	sample relative humidity value (%RH)
m1	non filtered mass in µg
o	reports “offline” in service mode, “online” if NOT in service mode
UA	beta count rate (1/s)
UB	beta zero count rate (1/s)

Command	Description
UC	alpha count rate (1/s)
UD	alpha zero count rate (1/s)
UQ	radon-EEC activity concentration (Bq/m³)
V	instrument model and software version
Z	read date/time of day answer: yy-mm-dd hh:mm:ss
ZZ	read date/time answer: yymmddhhmmss
?	read device address
#	flags

Table E–2. Write Commands for 5028*i*

Command	Description
d4	baud rate
d7	device address
K4	concentration factor
KB	filter change dust load in µg
KD	filter change cycle in hours
KG	external heating
KH	set point air flow regulation in l/h
KU	establishes the RH target value
KT	establishes the temp target value
K$	norm-Pressure
K%	norm-Temp
Y$	write parameters to EEPROM

Table E–3. Control Commands for 5028*i*

Command	Description
A	pump off
E	pump on
F	filter change

USA
27 Forge Parkway
Franklin, MA 02038
Ph: (800) 437-7979
Fax: (713) 272-2273
orders.process.us@thermofisher.com

India
C/327, TTC Industrial Area
MIDC Pawane
New Mumbai 400 705, India
Ph: +91 22 4157 8800
india@thermofisher.com

China
+Units 702-715, 7th Floor
Tower West, Yonghe
Beijing, China 100007
Ph: +86 10 84193588
info.eid.china@thermofisher.com

Europe
Ion Path, Road Three,
Winsford, Cheshire CW73GA UK
Ph: +44 1606 548700
Fax: +44 1606 548711
sales.epm.uk@thermofisher.com

Find out more at **thermofisher.com/5028i**

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