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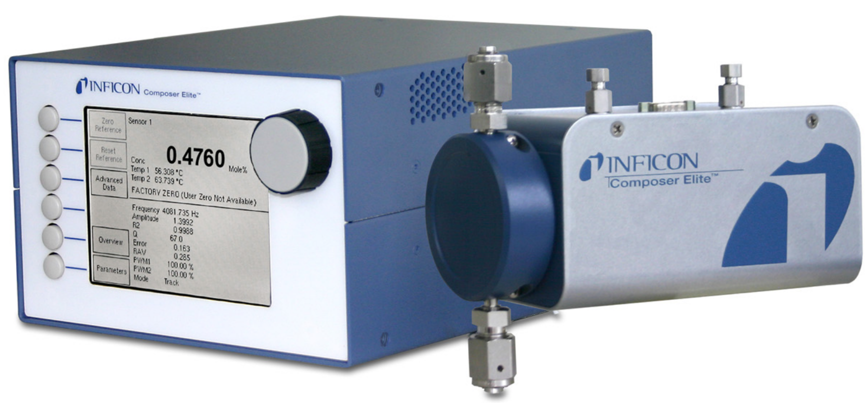

Composer Elite™

Gas Concentration Monitor

PN 074-566-P1C

INFICON

O P E R A T I N G   M A N U A L

Composer Elite™

Gas Concentration Monitor

PN 074-566-P1C

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OF
CONFORMITY

This is to certify that this equipment, designed and manufactured by:

INFICON Inc.
Two Technology Place
East Syracuse, NY 13057
USA

meets the essential safety requirements of the European Union and is placed on the market accordingly. It has been constructed in accordance with good engineering practice in safety matters in force in the Community and does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.

Equipment Description: **Composer Elite (including all options)**

Applicable Directives:
2014/35/EU (LVD)
2014/30/EU (General EMC)
2011/65/EU (RoHS2)

Applicable Standards:

Safety:	EN 61010-1: 2010 3.0 Edition
Emissions:	EN 61326-1: 2013 (Radiated & Conducted Emissions) (EMC – Measurement, Control & Laboratory Equipment) CISPR 11/EN 55011 Edition 2009-12 Emission standard for industrial, scientific, and medical (ISM) radio RF equipment FCC Part 15 and Part 18 Class A emissions requirement (USA)
Immunity:	EN 61326-1: 2013 (Industrial EMC Environments) Immunity per Table 2 (EMC – Measurement, Control & Laboratory Equipment)
RoHS2:	Fully Compliant

CE Implementation Date: **July 15, 2013** **(Revised 5/29/15)**

Authorized Representative: Steven Schill
Thin Film Business Line Manager
INFICON, Inc

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NOTE: These instructions do not provide for every contingency that may arise in connection with the installation, operation or maintenance of this equipment. Should you require further assistance, please contact INFICON.

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Chapter 1
Introduction

1.1 Introduction

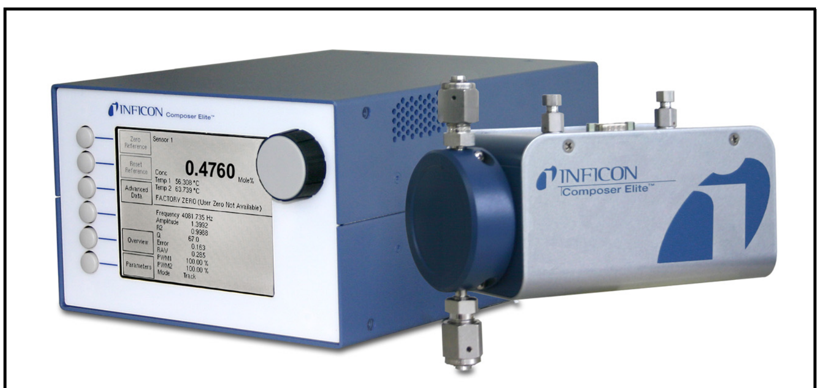
Composer Elite™ is designed to measure the precursor concentration of binary gases. It is optimized for operation at pressures as low as 26.66 kPa [200 Torr] and temperatures as high as 65°C. The Composer Elite System provides unsurpassed precision and reproducibility when measuring small concentrations of heavy molecular weight components in a lower molecular weight carrier gas.

1.1.1 Description of the Composer Elite System

The Composer Elite System consists of:

- A Sensor Control Unit which sends/receives electrical signals to/from the Acoustic Sensor. The Sensor Control Unit provides an LCD display and interface for user interaction (see Figure 1-1).
- An Acoustic Sensor which interfaces to the process gas tubing and forms the physical basis for the speed of sound measurement (see Figure 1-1). Two versions of Acoustic Sensor are available:
  - Standard Acoustic Sensor, for use with hydrogen or helium carrier gas at flow rates up to 2000 sccm, or for carrier gases of any molecular weight at flow rates up to 1000 sccm.
  - High Flow Acoustic Sensor, for use with nitrogen carrier gas or a higher molecular weight carrier gas, at flow rates between 1000 and 2000 sccm.
- An Interconnect Cable which connects the Sensor Control Unit and Acoustic Sensor.
- An optional 24 V(dc) Power Supply which provides power to the Sensor Control Unit.
- Windows® Composer Elite Multi-Sensor Software, for system operation and setup through RS-232C or DeviceNet. See Chapter 6, Composer Elite Multi-Sensor Software.

Figure 1-1 Sensor control unit (left), acoustic sensor (right)



1.2 Using this Manual

Please take a moment to read the following.

1.2.1 Symbols and their Definitions

NOTE: Notes provide additional information about the current topic.

HINT: Hints provide insight into product usage.

CAUTION

Failure to heed these messages could result in a malfunction or damage to Composer Elite.

WARNING

Failure to heed these messages could result in physical injury.

WARNING - Risk Of Electric Shock

Dangerous voltages are present which could result in personal injury.

1.2.2 General Cautions and Warnings

WARNING - Risk Of Electric Shock

Dangerous voltages are present inside the 24 V power supply whenever the power cord is connected. Do not open the power supply casing.

CAUTION

Composer Elite contains circuitry susceptible to transient mains voltages. Disconnect the power cord whenever making any interface connections.

CAUTION

Do not open the casing of any component of the Composer Elite System. There are no user-serviceable components inside. Refer all maintenance to qualified INFICON personnel.

WARNING

Do not install or use Composer Elite in a manner inconsistent with the instructions in this operating manual. Failure to do so may result in damage to the instrument or personal injury.

WARNING

Many of the precursor gases that can be used with Composer Elite are toxic. Refer to the material's Material Safety Data Sheet for information regarding personal safety.

1.3 How To Contact INFICON

Worldwide customer support information is available under **Contact >> Support Worldwide** at www.inficon.com

- Sales and Customer Service
- Technical Support
- Repair Service

If you are experiencing a problem with your Composer Elite or Composer Elite Multi-Sensor software, please have the following information readily available:

- The Sales Order or PO number for the Composer Elite purchase.
- The version of the software if you are calling about Composer Elite Multi-Sensor software.
- A description of the problem.
- An explanation of any corrective action that you may have already attempted.
- The exact wording of any error messages that you may have received.

1.3.1 Returning Your Composer Elite

Do not return any component of your Composer Elite System to INFICON without first speaking with a Customer Support Representative. You must obtain a Return Material Authorization (RMA) number from the Customer Support Representative.

If you deliver a package to INFICON without an RMA number, your package will be held and you will be contacted. This will result in delays in servicing your Composer Elite.

Prior to being given an RMA number, you will be required to complete a Declaration Of Contamination (DoC) form if your Acoustic Sensor is being returned. DoC forms must be approved by INFICON before an RMA number is issued. INFICON may require that the Acoustic Sensor be sent to a designated decontamination facility, not to the factory.

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1.4 Unpacking and Inspection

1. If Composer Elite has not been removed from its shipping container, do so now. Do not discard the packing materials before reading the following steps.
2. Carefully examine Composer Elite for damage that may have occurred during shipping. This is especially important if you notice obvious rough handling on the outside of the container. Immediately report any damage to the carrier and to INFICON.
3. Take an inventory of your order by referring to the configuration code in your order invoice and the information shown in section 1.4.1 and Figure 1-2.
4. Perform a power-up verification of the Sensor Control Unit. (See section 1.4.2.)
5. For additional information or technical assistance, contact INFICON (Refer to section 1.3).

1.4.1 Parts and Options Overview

Sensor Control Unit . . . . PN 761-220-G1

Acoustic Sensor

Standard . . . . PN 761-219-G1

High Flow . . . . PN 761-219-G2

NOTE: The High Flow Acoustic Sensor is identified by a "G2" marking on the inlet tube nut.

Interconnect Cable, 15 ft. (4.6 m). . . . . PN 600-1447-P15

Ship Kit. . . . . PN 761-619-G1 (contents: Leak Test Needle Kit; operating manual and Multi-Sensor software on CD)

Power Supply, 100-240 V(ac) (optional) . . . . . . PN 033-0056

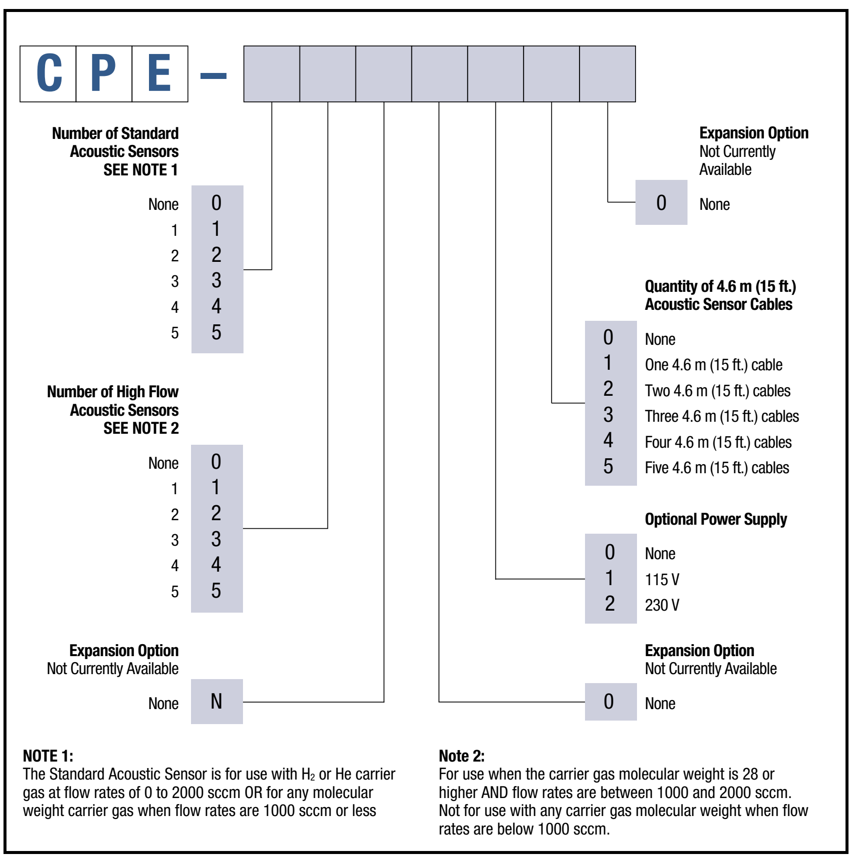
Power Cord, 115 V (optional). . . . . PN 068-0433

Power Cord, 230 V (optional). . . . . PN 068-0434

Full Rack Extender (optional). . . . . PN 782-900-007

RS-232 Cable, 4.6 m (15 ft.) (optional) . . . . PN 600-1001-P15

Figure 1-2 Composer Elite part number configuration



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1.4.2 Sensor Control Unit Power-Up Verification

It is not necessary to have Acoustic Sensors or communications cables connected to the Sensor Control Unit at this time.

1 Set the power switch on the rear panel of the Sensor Control Unit to the 0 (OFF) position. (See Figure 3-8 on page 3-15.)

2 Using the INFICON (optional) 24 V power supply, or a power supply as defined in section 1.5.4 and Table 1-1 on page 1-12, insert the output cable of the 24 V power supply into the connector labeled **150W 24V** on the rear panel of the Sensor Control Unit (see Figure 3-8 on page 3-15). Make certain the cable is inserted until it locks in place.

3 Connect mains power (refer to section 1.5.4.2 on page 1-12) to the input of the 24 V power supply.

4 Power up the Sensor Control Unit from the rear panel by setting the power switch to the 1 (ON) position. The **Boot** screen will appear followed by a **System Overview** screen.

4a Verify that the information displayed on the **Boot** screen is as described by section 3.3.2.1 on page 3-5.

4b Verify that the **System Overview** screen (see section 3.3.2.4 on page 3-8) appears after the **Boot** screen.

5 If the information displayed on the **Boot** screen is not as described by section 3.3.2.1, or if the **System Overview** screen does not appear, contact INFICON.

6 Power down the Sensor Control Unit by setting the power switch to the 0 (OFF) position.

1.5 Specifications

1.5.1 Composer Elite System Operating Specifications

Operating Pressure Range . . . . 26.7 to 133.4, kPa [200-1000 Torr] absolute

Routine Overpressure Rating. . . . . . Up to 202.7 kPa [1520 Torr] absolute

Maximum Overpressure. . . . . 826.2 kPa [6200 Torr] absolute. Pressure over 826.2 kPa may damage Acoustic Sensor diaphragms.

Gas Flow Range

Standard Acoustic Sensor (for H2 and He carrier gas). . . . . 0 to 2000 sccm, pressure drop at 2000 sccm flow is approximately 12 Torr [1.60 kPa] at standard temperature and pressure

High Flow Acoustic Sensor (for N2 carrier gas or higher molecular weight) . . . . . . 1000 to 2000 sccm, pressure drop at 2000 sccm flow is approximately 6 Torr [0.80 kPa] at standard temperature and pressure.

Measurement Stability . . . . 1 hour drift: +/- 0.032 Hz after 1 hour stabilization (equivalent to +/- 2.5 ppm Cp2Mg in N_2). 8 hour drift: +/- 0.025 Hz after 2 hour stabilization

Determined using a N_2 carrier gas at 60°C, 800 Torr, 100 sccm flow

Measurement Rate. . . . . 1 second

Concentration Reproducibility . . . . . <3 x 10-6 molar TMIn equivalent in H_2 [<2.4 x 10-5 molar TMIn equivalent in N_2]

Sensitivity . . . . Carrier at 60°C, 800 Torr, 100 sccm flow, 0.00011% of TMIn in H_2 [0.0008% of TMIn in N_2]

Time to Operation from Room Temperature . . . . For five Acoustic Sensors from ambient temperature to the "at temperature" condition is 120 minutes. Three or fewer sensors typically require 90 minutes or less.

Reliability and Serviceability. . . . . . . Mean Time Between Failure: >8000 hours

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1.5.2 Composer Elite Sensor Control Unit

Size H x W x D	132.8 x 213.4 x 254 mm (5.23 x 8.4 x 10.0 in.) 3U Half Rack
Measurement Channels	Up to 5 Acoustic Sensors supported with 1 Sensor Control Unit
Required Connector Clearance	76.2 mm (3 in.) at rear panel for electrical connector removal or insertion
Rack Mount	Optional; Full Rack Extender, PN 782-900-007
Weight	Approximately 3.0 kg (6.6 lb.)
Operating Temperature Range	20 to +50°C (68 to 122°F)
Storage Temperature Range	-10 to +70°C (14 to 158°F)
Humidity Range	0 to 80% RH non-condensing
Power Switch	Rear panel mounted circuit breaker rated at 7.5 A
Power Requirements	24 V(dc), 150 watts
Display	TFT LCD
Front Panel Keys	Six buttons for screen selection
Control Knob	For parameter selection and editing Rotate for parameter selection.
Rear Panel Connectors	Ground stud, power connection, 15-pin high-density D-sub connectors to sensor cards, 9-pin D-sub connector for RS-232C and M12x1 round connector for DeviceNet communications
Cleaning	The casing can be safely cleaned with a mild detergent or spray cleaner designed for that purpose. Care should be taken to prevent any cleaner from entering the unit
Regulatory Compliance	Certified to CE standards, RoHS compliant, & compliant to DeviceNet standards
Interconnect Cable	4.6 m (15 ft.) length, 15-pin high-density D-sub connector on each end

1.5.3 Acoustic Sensor

Size . . . . 124 mm (4.88 in.) between VCR-4 seal surfaces. Maximum outline dimensions W x H x D (with gaskets and caps) 77.7 x 149.9 x 185.4 mm (3.06 x 5.90 x 7.30 in.)

Measurement Principle . . . . Precursor concentration determined by precision measurement of speed of sound in a temperature controlled volume. Measurement quality is enhanced by a multi-chamber Helmholtz type resonator

Materials in Contact with Process Gas

Sensor Body. . . . . 316L Stainless Steel

Tubing . . . . Seamless 316L SS and automatic butt weld fittings

Isolation Diaphragms . . . . 0.017 mm (0.00067 in.) Inconel® X-750, sealed with Inconel 718 gold plated c-rings

Connection to Process
Gas System . . . . Swagelok® VCR®-4 male; inlet and outlet inline 124 mm (4.88 in.) seal face to seal face, near zero clearance required

Leak Test Service
Port Connection . . . . Swagelok VCR-2 female

Swept Volume . . . . Resonant chamber: 8.9 cc
Connecting Inlet and Outlet tubes (combined volume): 3.7 cc

Total Swept Volume . . . . 12.6 cc

Operating Temperature Range. . . . . 5°C minimum above ambient, range 30°C to 65°C, heat mode only

Maximum Leak Rate . . . . 1×10^{-9} cm^3/s helium

Electrical Connection . . . . 15-pin high-density D-sub to Sensor Control Unit

Required Connector Clearance . . . . Required clearance 76.2 mm (3 in.) one side for electrical connector removal or insertion

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Mounting Requirements . . . . M4-0.7 (4), max. screw penetration 6.4 mm (0.25 in.) depth threaded holes provided. Because the attachment to each system widely varies, a mounting bracket must be customer fabricated.

Weight . . . . Approximately 2.3 kg (5.1 lb.)

Storage Temperature Range . . . . . . -10 to +70°C (14 to 158°F)

Humidity Range . . . . 0 to 80% RH non-condensing

1.5.4 Power Supply

The following sections detail the electrical power specifications for the optional Power Supply. A universal input power supply converts local mains voltage to regulated and current limited 24 V(dc) for powering the Sensor Control Unit.

WARNING - Risk Of Electric Shock

Failure to comply with the electrical power requirements stated below may result in Composer Elite malfunctioning or being damaged, and could result in personal bodily injury.

1.5.4.1 Rated Output

Voltage . . . . 24 V(dc) +5% / -2%

Ripple and Noise . . . . 480 mV peak-to-peak max.

Current . . . . 6.25 A max.

Short Circuit Protection . . . . Continuous, hiccup mode

24 V Connector Interface . . . . Shielded Cable Assembly

Connector . . . . 4-pin, Kycon KPPx-4P or equiv.

Length. . . . . 1830 mm

Wiring Size . . . . #14 AWG

+24 V . . . . Pins 3, 4

Gnd . . . . Pins 1, 2

Shield Drain . . . . Shell

Shell . . . . Grounded

1.5.4.2 Rated Input

Operational Voltage Range . . . . 100 to 240 V(ac) +/- 10% (ac)

Frequency Range. . . . . 47 to 63 Hz

In-rush Current . . . . <60 A at 230 V(ac) input,
25°C ambient cold start

Input Current . . . . 2.5 A max.

Overvoltage . . . . 110% - 130% of nominal
(Cycle input power to reset)

Unit Mains Connector. . . . . IEC320-C14 (Accepts IEC 320-C13)

1.5.4.3 Power Supply Environmental Specifications

Operating Temperature . . . . 0 to +40°C

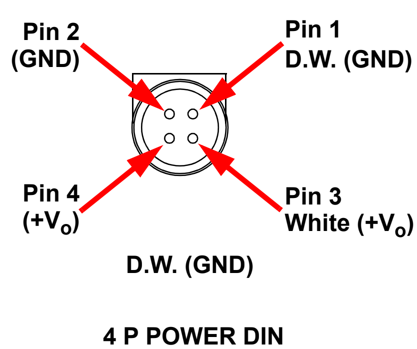
Storage Temperature . . . . -10 to +70°C

Humidity . . . . 20 to 90% non-condensing

1.5.5 User Supplied Power Supply

If the user provides their own power supply, it must conform to the specifications and requirements indicated by section 1.5.4. The power supply output cable must be wired to a 4-pin connector as shown in Table 1-1.

Table 1-1 +24 Volt power connector's pin diagram

Pin	Function	Wiring Diagram for Kycon KPPx-45 Plug
1	Gnd	
2	Gnd	
3	+24 V	
4	+24 V	

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1.5.6 Computer Requirements for Composer Elite Multi-Sensor Software

Processor . . . . 1 GHz

Memory . . . . 512 MB RAM

Display Resolution . . . . 1280 x 1024

Storage . . . . 5 MB of Hard Drive Space

Operating System. . . . . Windows XP (SP3), Windows 7

Communications. . . . . RS-232 Serial Port, or USB-Serial Adapter, or DeviceNet Card

Other . . . . Microsoft® .Net Framework 4 Client Profile (x86 and x64)

1.5.7 DeviceNet Requirements for Composer Elite Multi-Sensor Software

Interface Card. . . . . Beckhoff FC5201 DeviceNet Interface Card

Connectivity . . . . 1-Channel, PCI bus

Software . . . . Beckhoff TwinCAT I/O

Power . . . . 24 V(dc), external power supply

NOTE: These requirements do not apply when DeviceNet is used in conjunction with other software.

1.5.8 Mounting Requirements

- The Sensor Control Unit is designed for bench-top operation or mounting in a standard 48.26 (19 in.) rack using the optional Full Rack Extender (PN 782-900-007). The Sensor Control Unit occupies half the width of a standard rack, so a blank-off is provided with the optional Full Rack Extender.
- The Acoustic Sensor must be attached to a rigid mounting surface using the M4 threaded holes in the Acoustic Sensor cover. Maximum depth of screw penetration into M4 mounting holes is 6.4 mm (0.25 in.).
- Dimension from VCR-4 gland-to-gland is 12.4 cm (4.88 in.).

1.5.9 Ventilation Requirements

- The Sensor Control Unit is adequately ventilated when operating on a bench top or when installed in a standard 48.26 cm (19 in.) rack using the optional Full Rack Extender (PN 782-900-007).
- The Acoustic Sensor does not require ventilation.

1.5.10 Perimeter for Maintenance Access

- Acoustic Sensor to be removed from the process gas tubing (Swagelok VCR-4 fittings) require side-to-side or top-to-bottom clearance of 16 cm (6 in.) for wrench rotation.
- Interconnect Cable to be removed or replaced from either Acoustic Sensor or Sensor Control Unit requires 8 cm (3 in.) clearance.
- Sensor Control Unit to be removed from rack, full 30.5 cm (12 in.) length required.

1.5.11 Environmental Requirements

The following detail Composer Elite environmental requirements.

Operation . . . . Composer Elite is designed for indoor use only.

Altitude Range . . . . Composer Elite can be used to a maximum altitude of 2000 m (6561 ft.).
For applications above this altitude, please contact INFICON.

Maximum Humidity. . . . . Non-condensing relative humidity at operating temperature.

Pollution Degree. . . . . Category II (as defined by EN61010-1, only non-conductive pollution occurs).

Operating Temperature . . . . Refer to section 1.5, Specifications, on page 1-8.

Chapter 2
Installation

2.1 Composer Elite Installation Guidelines

The requirements and recommendations in section 2.1.1, section 2.1.2, and section 2.1.3 must be reviewed and understood before Composer Elite is installed as described by section 2.2, Composer Elite Installation, on page 2-8.

2.1.1 Pressure, Temperature, and Tubing

2.1.1.1 Maximum Pressure

Reliable measurement of concentration to absolute pressures as low as 26.66 kPa (200 Torr) requires relatively thin and flexible diaphragms to be used so that sufficient acoustic energy may be transmitted.

There is a possibility that the diaphragms may destructively rupture if an absolute pressure greater than 826 kPa (6200 Torr) is applied. A secondary containment chamber is built into the Acoustic Sensor to prevent process gases from escaping the Acoustic Sensor in the event of a diaphragm rupture.

CAUTION

Do not connect the Acoustic Sensor to process tubing that can exceed an absolute pressure of 826 kPa (6200 Torr). Exposing the Acoustic Sensor to excess pressure may cause catastrophic diaphragm failure or may stretch the diaphragms, requiring on-site reference zeroing (see section 4.1.2 on page 4-1).

A certified rupture disk should be installed upstream of the Acoustic Sensor to limit any possible over-pressure to less than 826 kPa (6200 Torr).

2.1.1.2 Pressure and Tubing Size

The Composer Elite System is designed to operate with the gases in the Reactor's process tubing at a pressure of 26.66 to 133.3 kPa (200 to 1000 Torr). The inner diameter of the inlet and outlet tubes on the Standard and High Flow Acoustic Sensors were designed to optimize performance at low pressures; however, the Reactor's process tubing may be of any appropriate size without degrading Composer Elite performance.

2.1.1.3 Heated Process Tubing and Acoustic Sensor Temperatures

Operation of the Acoustic Sensor at a temperature slightly higher than the process gas tubing will help prevent material from condensing inside the acoustic sensor.

INFICON recommends the following temperature settings:

- The **Temperature Setpoint 1** setting for the Acoustic Sensor's resonant chamber temperature should be 5°C or more above ambient temperature. See section 3.3.2.7, Sensor Parameters Screen, on page 3-13.
- The **Temperature Setpoint 2** setting for the Acoustic Sensor's inlet tube temperature should be above the **Temperature Setpoint 1** setting. Typically start out with this temperature three degrees above Temperature Setpoint 1. The inlet tube heater is designed to minimize zero point offset caused by large flow rate changes. The optimal setting will depend on process conditions. See section 3.3.2.7, Sensor Parameters Screen, on page 3-13.

2.1.2 Grounding and Shielding

2.1.2.1 Power Supply Grounding Requirement

WARNING - Risk Of Electric Shock

The Composer Elite 24 V Power Supply must be connected to a grounded socket outlet using a three-conductor power cable with ground terminal.

The Composer Elite 24 V power supply (optional) is connected to ground through a sealed three-conductor power cable, which must be plugged into a socket outlet with a protective ground terminal. Extension cables must always have three conductors including a protective ground terminal.

2.1.2.2 Earth Ground Requirement

CAUTION

A low impedance and reliable earth ground is required for proper performance of Composer Elite.

If local facilities engineering cannot provide a low impedance earth ground close to Composer Elite, the following procedure is recommended.

1. Where soil conditions allow, drive two 3 m (10 ft.) copper clad steel rods into the ground 2 m (6 ft.) apart.
2. Pour a copper sulfate or other salt solution around the rods to improve the soil's conductivity.

A near zero resistance measurement between the two rods indicates that a desirable earth ground is established. In severe cases, it may take several soakings of solution over several days to reach this condition.

NOTE: Keep connections to this grounding network as short as possible. Most noise transients contain significant power at high frequencies. A long path adds to the ground circuit's inductance and thereby increases its impedance at these frequencies.

2.1.2.3 Composer Elite System Grounding Requirement

CAUTION

The Sensor Control Unit and Acoustic Sensor must be grounded for proper performance of Composer Elite.

The following grounding method is recommended:

1 Verify that the Reactor is connected to a good, reliable earth ground (refer to section 2.1.2.2, Earth Ground Requirement, on page 2-3). Use a solid copper strap, at least 0.08 cm (0.030 in.) thick by 2.5 cm (1 in.) wide, and as short as practical, for the connection between Reactor and earth ground (see Figure 2-1).

2 Use a solid copper strap, approximately 0.08 cm (0.030 in.) thick by 2.5 cm (1 in.) wide, and as short as practical, between the Sensor Control Unit ground stud (see Figure 2-1) and the Reactor. A ring terminal soldered to the ground strap will allow for a good connection to the ground stud and convenient removal or installation.

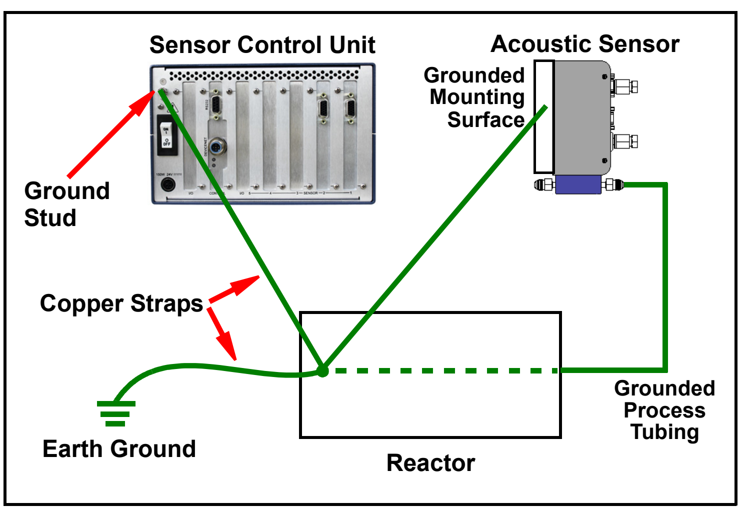
3 Connect the Acoustic Sensor to earth ground by one or both of the following methods:

3a Use the M4 mounting holes provided on the Acoustic Sensor to attach the Acoustic Sensor to a metal mounting surface that is connected to earth ground (see Figure 2-1 and section 2.2.2 on page 2-9).

or

3b Connect the Acoustic Sensor's outlet tubing to process tubing that is connected to earth ground (see Figure 2-1 and section 2.2.2 on page 2-9).

Figure 2-1 System grounding diagram



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2.1.2.4 Electrical Interference Reduction

When Composer Elite is integrated into a deposition system, each cable connection is a potential path for electrical noise to be conducted to the Sensor Control Unit or Acoustic Sensor. The possibility of external electrical interference problems can be greatly reduced by adhering to the following guidelines:

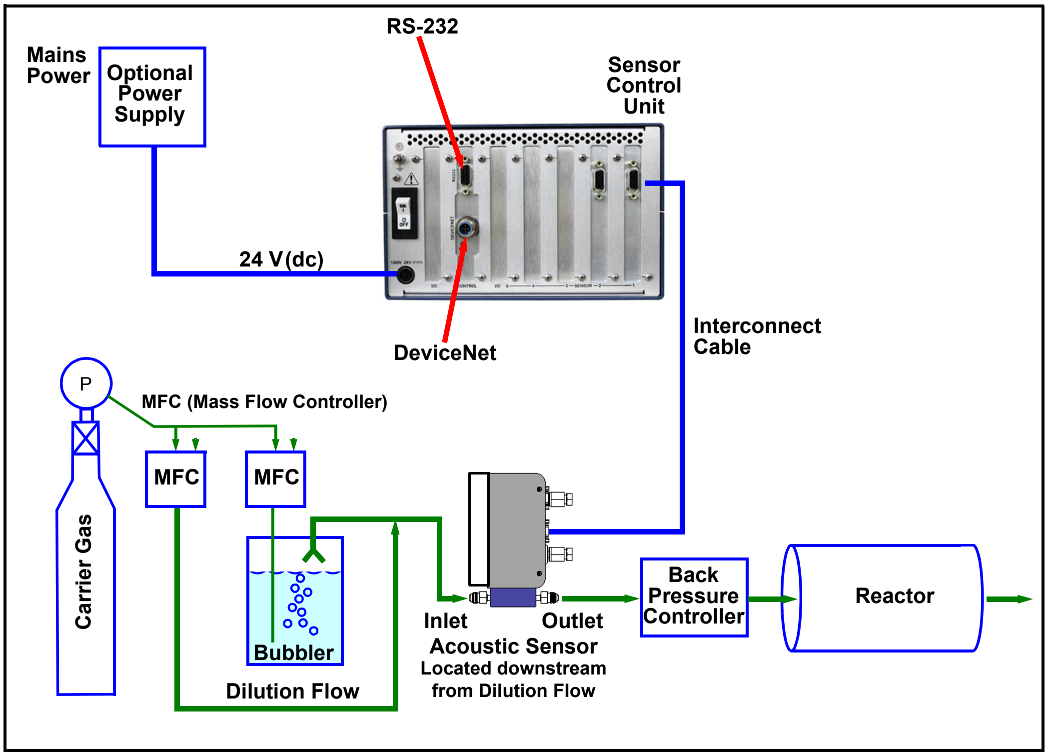
- Make certain the Sensor Control Unit and Acoustic Sensor are properly grounded. (Refer to section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.)
- Make certain the Sensor Control Unit covers and option panels are in place and secured with the provided fasteners.
- Use shielded cable as short as practical for remote communications.
- Avoid routing the Composer Elite Interconnect cable and communications cable near areas that have the potential to generate high levels of electrical interference. For example, large power supplies can be a source of large and rapidly changing electromagnetic fields. Placing cables at least 30 cm (1 ft.) from these problem areas can result in a significant reduction of electrical interference.

2.1.3 Composer Elite Location Selection

2.1.3.1 Selecting The Acoustic Sensor Location

Locate the Acoustic Sensor at a point after the Dilution Flow gas is added and before the Back Pressure Controller. (See Figure 2-2 on page 2-6.) This creates the environment with the most stable pressure and flow conditions for best Composer Elite stability. Positioning the Acoustic Sensor after the Dilution Flow also simplifies calibration by making it easy to flow pure carrier gas through the Acoustic Sensor to set the Reference Zero.

Figure 2-2 Basic integration with a reactor



The Acoustic Sensor may be installed in any orientation, however, INFICON recommends the normal inlet and outlet tube convention (refer to Figure 2-2) be followed. The inlet tube is substantially longer than the outlet tube to facilitate temperature equalization. If the inlet and outlet tube connections are reversed, there may be a small frequency or concentration offset when the total gas flow through the sensor is varied.

Ventilation clearance is not required; however, the surface the Acoustic Sensor is mounted to must be at least 5°C below Temperature Setpoint 1.

The dimension from inlet tube VCR-4 sealing surface to outlet tube VCR-4 sealing surface is 124 mm (4.88 in.).

Acoustic Sensor installation or removal from process tubing requires side-to-side or top-to-bottom clearance of 152.4 mm (6 in.) for wrench rotation.

Interconnect Cable installation or removal requires 76.2 mm (3 in.) clearance.

The Interconnect Cable route should be planned to minimize external electrical interference. (Refer to section 2.1.2.4, Electrical Interference Reduction, on page 2-5.)

2.1.3.2 Selecting The Sensor Control Unit Location

The Sensor Control Unit is designed for bench top operation or mounting in a standard 48.26 cm (19 in.) rack using the optional Full Rack Extender (PN 782-900-007). Ventilation is adequate when operating on a bench top or when installed in a standard rack using the optional Full Rack Extender.

WARNING

If the Sensor Control Unit will not be mounted in a standard rack, select a location where the Sensor Control Unit is protected against falling to prevent instrument damage and personal injury.

Sensor Control Unit removal from a standard rack requires 30.5 cm (12 in.) clearance in front of the rack.

Clearance of 7.62 cm (3 in.) is required at the rear of the Sensor Control Unit for installation or removal of Interconnect, Power Supply, RS-232, and DeviceNet cables.

Sensor Control Unit location should be selected to minimize the length of the grounding strap. (Refer to section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.)

Interconnect Cable and communication cable routes should be planned to minimize external electrical interference. (Refer to section 2.1.2.4, Electrical Interference Reduction, on page 2-5.)

2.2 Composer Elite Installation

2.2.1 Installing The Sensor Control Unit in a 19 in. (48.26 cm) Rack

Install the Sensor Control Unit in a standard 48.26 (19 in.) rack using the optional Full Rack Extender (PN 782-900-007).

1. Assemble the two 7.62 x 12.7 cm (3 x 5 in.) Extender Kit side panels and the larger front and rear panels into a box configuration using the eight 6-32 flat-head screws.
2. Thread two 10-32 shoulder screws from the inside of one of the box sides until the threads extend fully to the outside.
3. Attach the Extender Kit to the Sensor Control Unit by threading the shoulder screws into the matching holes in the Sensor Control Unit covers.
4. Attach the rack mounting ears with the 10-32 flat-head screws provided.
5. Carefully lift the assembly into a full width, 13.33 cm (5-1/4 in.) high rack space.
6. Attach the assembly to the rack using the necessary screws (not provided).
7. Connect the Sensor Control Unit to earth ground as described by section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.

CAUTION

Connect the Sensor Control Unit to earth ground as described by section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.

2.2.2 Installing The Acoustic Sensor

WARNING

Many gases used for film growth are toxic at very low exposure levels.

CAUTION

Although the Acoustic Sensor was thoroughly leak tested at the factory, periodic leak testing of the Acoustic Sensor is recommended. See section 7.2, Leak Test Procedures, on page 7-1.

1. Remove the caps from the VCR-4 fittings on the Acoustic Sensor's inlet and outlet tubes by holding the fitting stationary with a 5/8 in. wrench while turning the cap counterclockwise with a 3/4 in. wrench. Do not discard the caps.
2. Remove and discard the gaskets from the VCR-4 fittings.
3. Mount the Acoustic Sensor securely to a rigid surface, using the four holes with M4 thread, to prevent stress at the inlet and outlet tubing welds and seals. See Figure 2-3 and Figure C-2 on page C-3.

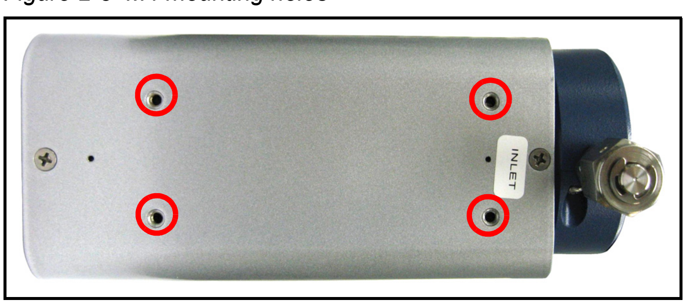
CAUTION

Do not use the inlet and outlet tubing to support the weight of the Acoustic Sensor.

CAUTION

Maximum allowable depth of screw penetration into the M4 mounting holes is 6.4 mm (0.25 in.).

Figure 2-3 M4 mounting holes



4 Install new VCR-4 gaskets (see section 7.3, Spare Parts, on page 7-5) into the VCR fittings on the inlet and outlet tubes.

NOTE: Gaskets with retainers are directional and easily snap over the face of the gland seal. (See Figure 2-4.)

Figure 2-4 Installation of gasket with retainer on gland

5 Connect the Acoustic Sensor to the process tubing using a 5/8 in. wrench to tighten the VCR fittings on the inlet and outlet tubes while holding the VCR fittings on the process tubing stationary with a wrench.

NOTE: Swagelok recommends tightening VCR type fittings 1/8 turn past finger-tight for nickel and stainless steel gaskets.

CAUTION

Verify that the Acoustic Sensor is connected to earth ground as described by section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.

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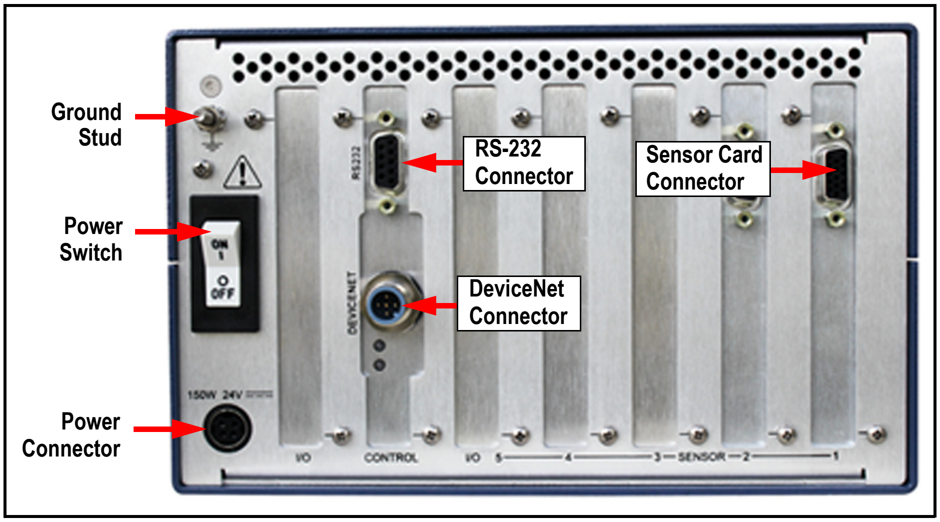
2.2.3 Installing Interconnect, Power Supply, and Communications Cables

1 Set the Sensor Control Unit power switch to 0 (OFF). (See Figure 2-5.)

CAUTION

Composer Elite contains circuitry susceptible to transient mains voltages. Make certain Composer Elite is powered down whenever making any interface connections.

Figure 2-5 Sensor control unit connections



2 Connect the Interconnect Cable(s) male D-sub connector to the Sensor card(s) connector. (Refer to Figure 2-5.) Tighten the thumb screws on the cable connector to secure the cable to the Sensor card.

CAUTION

Make certain the Interconnect Cable D-sub connectors are correctly oriented with the Sensor card / Acoustic Sensor connectors to avoid damaging connector pins.

3 Connect the Interconnect Cable(s) female D-sub connector to the Acoustic Sensor(s) connector. Tighten the thumb screws on the cable connector to secure the cable to the Acoustic Sensor.

4 If applicable, connect the RS-232 cable to the Control card RS-232 connector, or connect the DeviceNet cable to the Control card DeviceNet connector. (Refer to Figure 2-5.)

5 Insert the 24 V Power Supply output-cable connector into the Sensor Control Unit power connector until it locks in place. (Refer to Figure 2-5.)

6 Connect the power cord to the 24 V Power Supply inlet receptacle.

7 Connect the power cord plug to Mains power. (Refer to section 1.5.4.2, Rated Input, on page 1-12.)

2.2.4 Installing Composer Elite Multi-Sensor Software

See section Chapter 6, Composer Elite Multi-Sensor Software, on page 6-1.

Chapter 3
Operation

3.1 Initialization and Setup

Application-specific parameter values must be entered, or downloaded, to Composer Elite. The parameters include the gases' Specific Heat Ratios and Molecular Weights.

3.1.1 Parameter Entry

Parameter values may be downloaded to Composer Elite by:

- Composer Elite Multi-Sensor Software, see Chapter 6.
- Remote communications using the protocol and commands in Chapter 5.
- Composer Elite front panel.

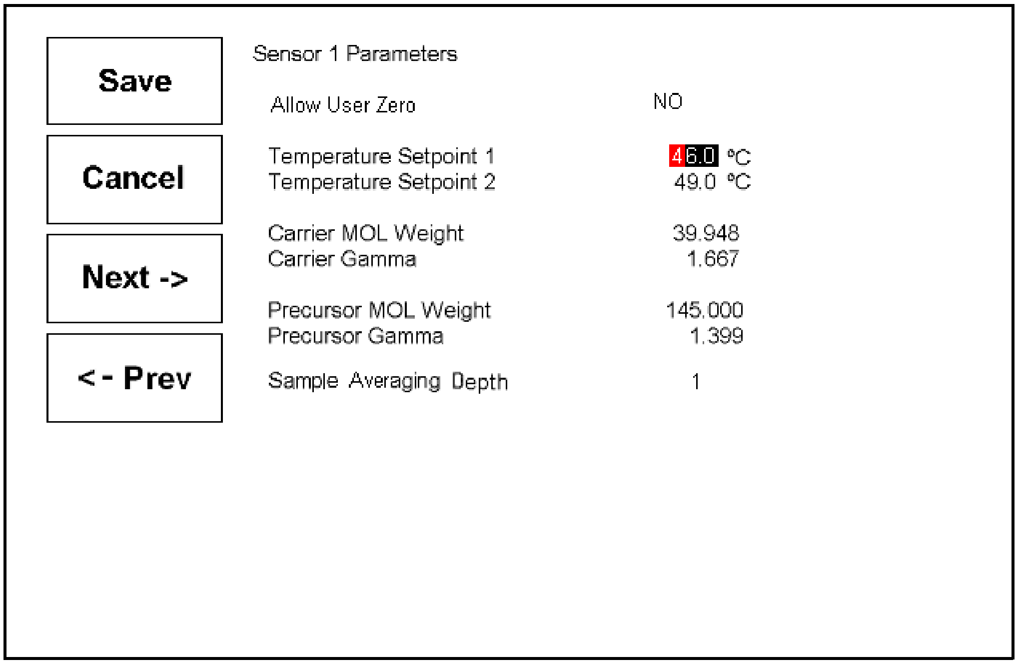
3.1.1.1 Composer Elite Front Panel Parameter Entry

Composer Elite front panel parameter entry uses buttons 1 - 6 and the Control Knob (7) shown in Figure 3-1. The function of the buttons vary, depending on the screen displayed and parameter highlighted.

Figure 3-1 Front panel buttons

When viewing editable parameters, **Edit** is available. Position the cursor on the parameter to edit by rotating the control knob. Press **Edit** to change parameter values. The left-most digit of the numerical parameter being edited will now be highlighted in red. Use **Next** and **Prev** to highlight the digit to edit, then rotate the control knob to change the value for that digit. To save the changes, press **Save**. To cancel changes, press **Cancel**. See Figure 3-2 for an example of screen layout while editing parameters.

Figure 3-2 Editing parameters



3.2 Calibration

Calibration obtains the exact frequency (speed of sound) for the carrier gas (or one component of a mixture) for specific Composer Elite System operating conditions. Calibration determines Reference Zero.

For many applications, Factory Zero is sufficient to provide the needed levels of accuracy and reproducibility. Refer to section 4.1.3, How is Performance Affected by using the Factory Zero Value?, on page 4-2.

3.2.1 Frequency of Calibration

Applications requiring the highest degree of reproducibility should be calibrated daily. Experience will determine if less frequent calibrations are appropriate. See:

- When and How Often to Set the Reference Zero, section 4.1.2 on page 4-1
- How is Performance Affected by using the Factory Zero Value?, section 4.1.3 on page 4-2
- What Happens if the Reference Zero is Improperly Set?, section 4.1.10 on page 4-8

3.2.2 Special Tools and Materials

Flowing a pure gas through the Acoustic Sensor at process pressure and flow rate is required for calibration.

NOTE: For guaranteed safe operation, a calibrated high-performance mass spectrometer leak detector should be used to check leak integrity whenever the Acoustic Sensor has been removed and reinstalled.

3.2.3 How to Calibrate

1. In the Sensor Parameters pane, set **ALLOW USER ZERO** to **YES**.
2. Flow calibration gas, usually pure carrier gas, through the Acoustic Sensor at normal operating pressure and flow rate.
3. Allow sufficient time for the calibration gas to cleanse any mixed gases out of the Resonant Chamber. The carrier gas has displaced all of the formerly contained gas mixes when the concentration stops changing.
4. **STEADY** and **AT TEMP** indicators will be displayed to indicate that the concentration and cell temperature are stable.
5. Set the new Reference Zero value by
   - On Composer Elite Multi-Sensor Software, click **Zero Reference**
   - On the Composer Elite front panel, on the **Sensor** window, press **Zero Reference**
6. The new Reference Zero is displayed on screens as **User Zero**.

3.2.4 How To Revert To Factory Default Settings

Factory Zero is re-established by changing any parameter value affecting concentration measurement, such as **Acoustic Sensor Setpoint 1 Temperature**, **Specific Heat Ratio** or **Molecular Weight** or by pressing **Reset Reference** on the Composer Elite front panel on individual **Sensor** screens.

Composer Elite may be reset to the default parameters by holding **1** and **6** down while powering up the instrument. **Data Reset** will be displayed on the **Boot** screen if this is successful. **Parameters Reset** will be displayed on the **Errors and Warnings** screen.

3.3 How To Use Composer Elite

The following sections explain how to start, stop, and power down Composer Elite. A description and purpose of the operating modes, displays, and system I/O connectors is also provided.

3.3.1 How to Power Up and Power Down Composer Elite

Operating Composer Elite requires a 24 V power connection. Refer to section 1.5.4 on page 1-11 for complete power specifications.

To power up Composer Elite,

1. Connect the 24 V(dc) power supply (see section 1.5.4, Power Supply, on page 1-11).
2. Set the ON/OFF (I|O) power switch on the rear panel of the Sensor Control Unit in the ON (I) position (see Figure 3-8 on page 3-15).

To power down Composer Elite, set the rear panel of the Sensor Control Unit in the ON (I) position in the OFF(0) position.

CAUTION

When powering down Composer Elite, make sure the precursor gases are completely purged from the Acoustic Sensor. When power is removed from the Sensor Control Unit, the Acoustic Sensor temperature will cool to room temperature. If precursor gases are not completely purged, condensation of precursor gas inside the Acoustic Sensor may occur as the Acoustic Sensor cools down.

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3.3.2 Composer Elite Screen Descriptions

3.3.2.1 Boot Screen

During power-up of the Sensor Control Unit, the INFICON logo is displayed. The following information is briefly displayed before the **System Overview** screen is displayed:

- **Version x.xx.xx HW x** (Control card firmware version and hardware version)
- **Loading....... Please Wait** (while Data, Sensor, and DeviceNet statuses are being determined) followed by **Loading....... Complete**
- **Data Wait** followed by:
  - **Data OK** (if parameter values were retained in memory)
  - **Data Reset** (if memory was cleared to factory default parameter values; refer to section 3.2.4 on page 3-3)
  - **Parameter Error** (contact INFICON if this message appears)
  - **Sensor Data Error** (contact INFICON if this message appears)
  - **System Data Error** (contact INFICON if this message appears)
- **Searching** followed by:
  - **DeviceNet Detected** (if a DeviceNet module is installed in the Control card)
  - **DeviceNet Not Detected** (if a DeviceNet module is not installed)
  - **DeviceNet Error** (if there is a problem with the DeviceNet module)
- **Initializing** followed by:
  - **Sensor n Detected** (for installed Sensor cards)
  - **Sensor n Not Present** (for empty Sensor card slots)
  - **Sensor n Initialization Failed** (if there is a problem with a Sensor card)

3.3.2.2 Indicators Displayed On Screens

AT TEMP . . . . Indicates that the temperature is within ±0.002°C of **Temperature Setpoint 1** and ±0.005°C of **Temperature Setpoint 2**. The text is displayed in green.

NEAR TEMP . . . . Indicates that the current temperature is near the desired temperature for **Temperature Setpoint 1**. The text is displayed in blue.

BELOW TEMP . . . . Indicates that the current temperature is below the desired temperature for **Temperature Setpoint 1**. The text is displayed in orange.

ABOVE TEMP . . . . Indicates that the temperature is higher than the desired temperature for **Temperature Setpoint 1**. The text is displayed in red.

STEADY . . . . Indicates that the concentration for the last seven measurements have an average error less than 0.5 Hz and the drift is less than twice the error. The text is displayed in green.

3.3.2.3 Overview Screen

Composer Elite will attempt to measure concentration and control Acoustic Sensor temperatures to setpoints whenever it is powered up. It will give correct readings when the pressure is within the specified range and correct values for the gases' Molecular Weights and Specific Heat Ratios that have been entered (see Table B-1 on page B-1) and Factory Zero is used.

CAUTION

If a new Reference Zero is required, section 3.2.3, How to Calibrate, on page 3-3 must be followed for establishing Reference Zero with the correct pure calibration gas or incorrect concentration values will be calculated.

The **Overview** screen displays each of the five available sensor channels, displaying sensor Concentration (**Conc**) and Temperature 1 and 2 (**Temp**) for all five sensors (see Figure 3-3). Unoccupied sensor slots are displayed in **grey**. Temperature value will be displayed as **99.999** for cards that are installed with no sensor attached.

Indicators (described above in section 3.3.2.2) display when appropriate.

Concentration is displayed in Mole%.

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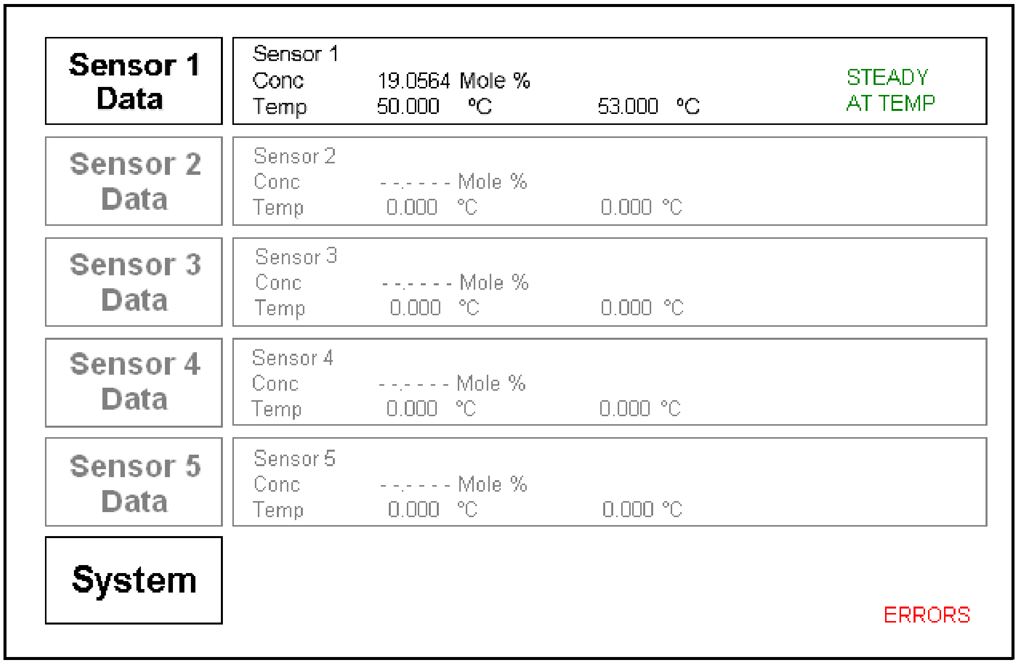
ERRORS, **WARNINGS**, or **ERRS & WRNS** may be displayed, depending on whether errors, warnings, or both are present (see section 3.3.2.5). If no errors or warnings are present, this area will be blank.

Figure 3-3 Overview screen



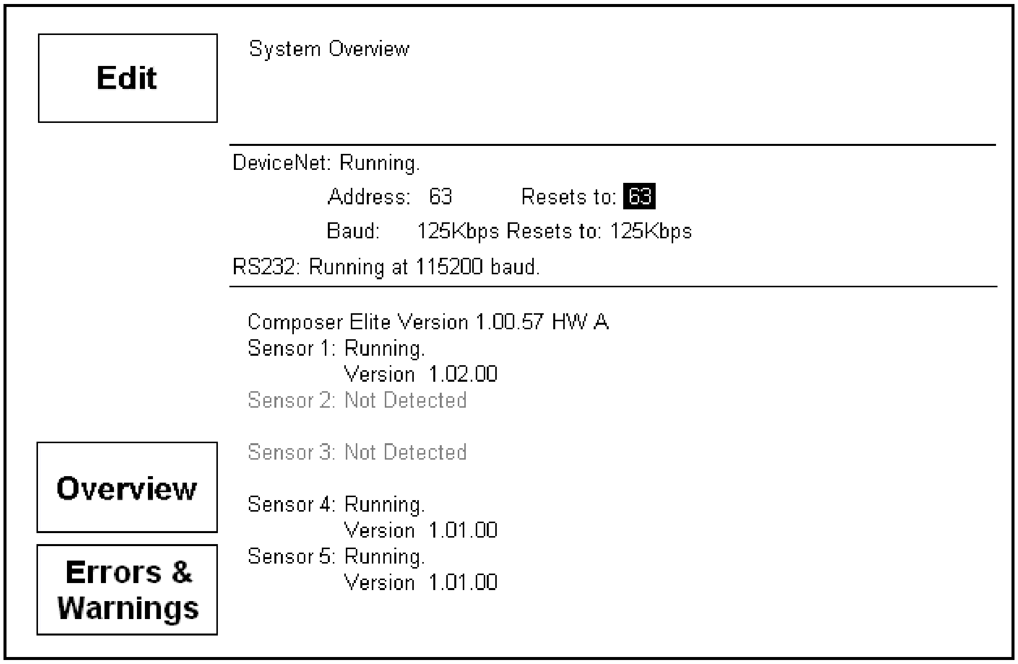
Buttons 1 through 5 represent **Sensor 1 Data**, **Sensor 2 Data**, etc. To enlarge and view data for an individual sensor, press the button associated with that sensor number to enter the **Sensor** screen. For example, press **Sensor 1 Data** to view data for sensor 1.

System will display the **System Overview** screen.

3.3.2.4 System Overview Screen

The **System Overview** screen displays information about the system's hardware. It displays remote communication port information such as the DeviceNet address and the RS-232 Baud rate. It also displays the firmware version, hardware version, and the version number and status for any installed sensor cards.

Figure 3-4 System Overview screen



Press **Edit** to edit the DeviceNet address and the DeviceNet Baud Rate.

- The DeviceNet address can be adjusted to values of **0-63**, appropriate to the network topology. The default value is **63.**
- The DeviceNet Baud Rate can be changed to **125**, **250**, or **500** Kbps. The default value is **125**.

  NOTE: RS-232 baud rate cannot be changed. It is always **115200** baud.

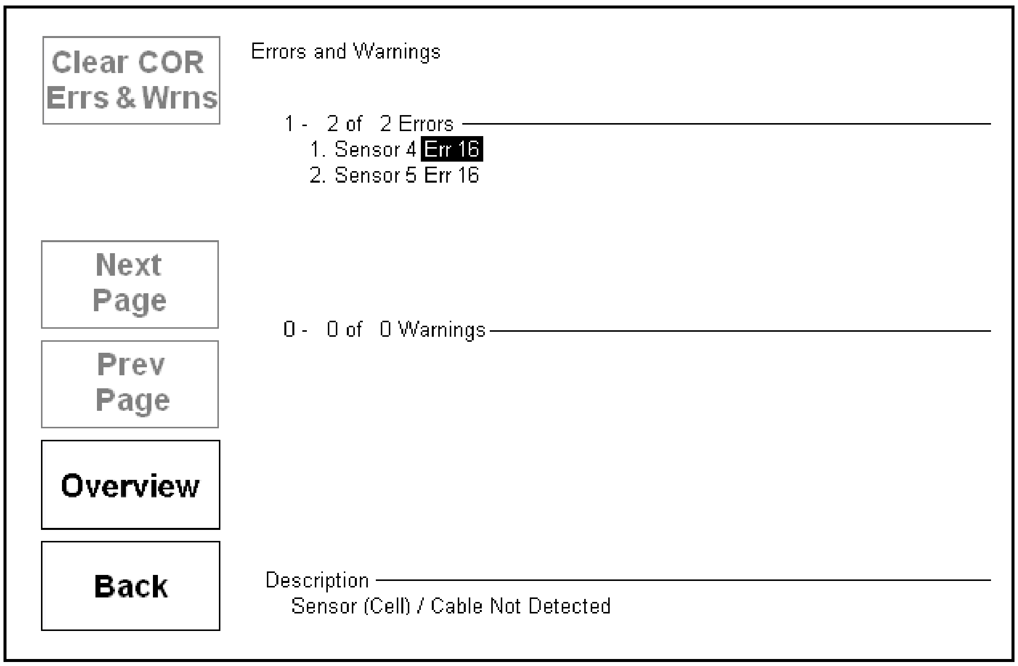
Pressing **Overview** will display the **Overview** screen.

Pressing **Errors & Warnings** will display the **Errors and Warnings** screen.

3.3.2.5 Errors and Warnings Screen

The **Errors and Warnings** screen displays current hardware errors or warnings. The error is listed with its sensor number (if applicable) and its error code. Use the control knob to scroll through the list of errors and/or warnings. At the bottom of the screen is a description of the highlighted error/warning. Details on system errors and warnings can be found in Table 5-22 on page 5-32 and Table 5-23 on page 5-34. A total of twelve errors and twelve warnings can be simultaneously displayed. If more than twelve errors or warnings are present, a second page will display the remaining errors.

Figure 3-5 Errors and Warnings screen



Pressing **Clear COR Errs & Wrns** (when available) will clear any COR (Clear On Read) errors or warnings present. See Table 5-22 on page 5-32 and Table 5-23 on page 5-34 for more information about COR errors and warnings.

Use **Next Page** and **Prev Page** to navigate from page to page if there are more than twelve errors or warnings listed.

Overview will display the **Overview** screen.

Back will navigate back to the **System Overview** screen.

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3.3.2.6 Sensor Screen

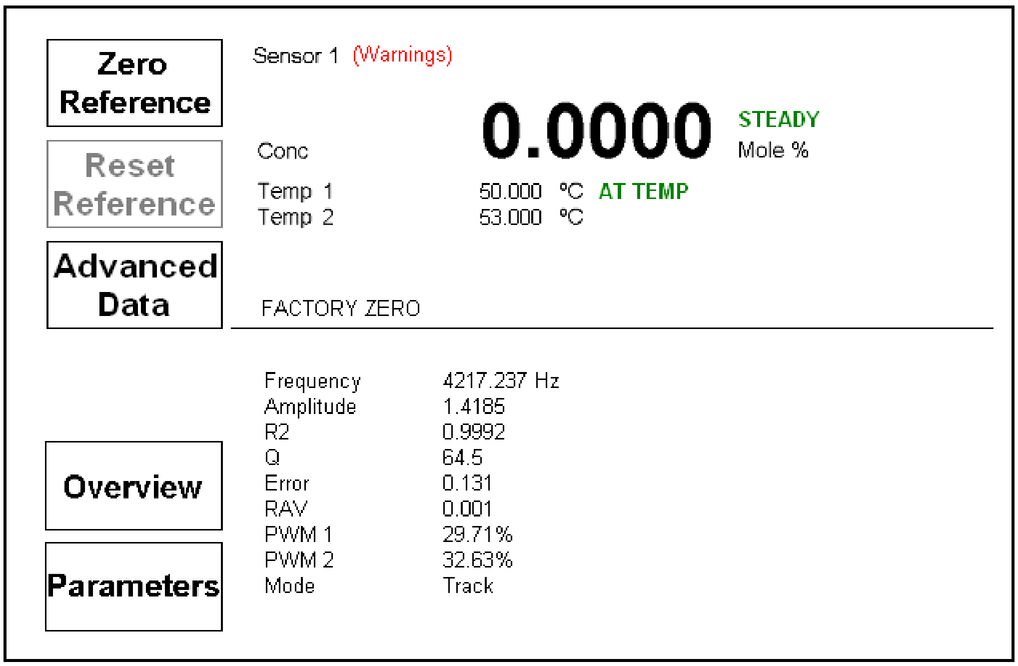
On the **Overview** screen, press **Sensor Data** to display the **Sensor** screen (see Figure 3-6). Data displayed on the **Sensor** screen is for an individual sensor. Data includes Concentration (**Conc**), **FACTORY ZERO** status, **Temp 1** and **Temp 2**.

Indicators (described in section 3.3.2.2 on page 3-6) display when appropriate.

Errors, **Warnings** or **Errors & Warnings** may be displayed, depending on whether errors, warnings, or both are present. If no errors or warnings are present, this area will remain blank.

Zero Reference, Reset Reference, Overview, Parameters, and **Advanced Data** are available.

Figure 3-6 Sensor screen



During Calibration, pressing **Zero Reference** sets a new Zero Reference point. **Zero Reference** is only available if the system meets the **AT TEMP** and **STEADY** conditions and if **ALLOW USER ZERO** is set to **YES** on the **Sensor Parameters** screen.

Reset Reference re-establishes the Factory Zero setting and is only available when **User Zero** is displayed. Both buttons appear **grey** when they are not available.

If Factory Zero is used, **FACTORY ZERO** is displayed.

If the sensor parameter **ALLOW USER ZERO** is set to **NO**, or if the Composer Elite Sensor Control Unit is not connected to a Composer Elite Acoustic Sensor, **(USER ZERO NOT AVAILABLE)** will be displayed next to **FACTORY ZERO**.

If a user-defined zero is being used, **USER ZERO** is displayed.

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Pressing **Advanced Data** displays acoustic information when a cell is attached. This information displayed includes:

Frequency . . . . The acoustic resonant frequency (measured in Hz) of the gas currently flowing through the cell. This value will increase/decrease as the concentration of the gas increases and decreases.

Amplitude . . . . Signal amplitude (measured in Volts RMS) of the measured frequency. This value will not be needed in normal operation but may be useful for troubleshooting.

R2 . . . . Coefficient of Determination - Lorentzian curve's "goodness of fit." (0<=R2<=1 where, 1 is perfect curve fit).

Q . . . . Resonant frequency's Quality Factor or Q factor. A measure of the sharpness of the peak. Not useful for most applications. This value should be greater than 5 in stable conditions.

Error . . . . Lorentzian curve fit's Standard Error from Acoustic Cell resonance points.

RAV . . . . Root Allen Variance frequency calculated from 201 measurements. The number of frequency points that vary from the normal at any given resonant frequency. The lower this number is the better the signal quality.

PWM1 . . . . Power (Duty Cycle %) applied to cell heater. This value is controlled by the Composer Elite and is only useful for troubleshooting.

PWM2 . . . . Power (Duty Cycle %) applied to (internal) inlet tube heater. This value is controlled by the Composer Elite and is only useful for troubleshooting.

Mode . . . . Displays the sensor card's current measurement mode. Modes include **Ready**, **Baseline**, **Search**, **Track**, and **QTrack**. See Table 3-1 for descriptions of these modes. Values for concentration will not be displayed while in Ready, Baseline or Search mode.

On the **Sensor** screen, pressing **Overview** displays the **Overview** screen, see section 3.3.2.3**.** To view the **Sensor Parameters** screen for the sensor, press **Parameters**. There is no direct way of moving from one Sensor screen to another. For example, to go from Sensor 1 to Sensor 2, exit to the **Overview** screen and select **Sensor 2 Data**

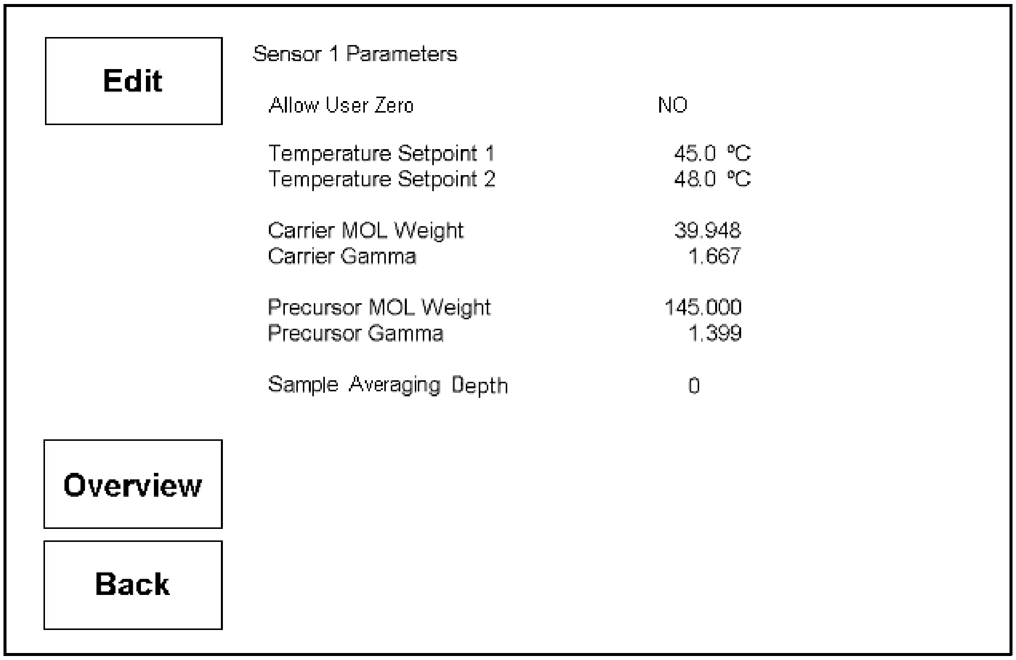
Table 3-1 RS-232C 9-pin type "D" connector pin connections

Mode	Description
Ready	Sensor card is not attempting to measure a resonance.
Baseline	Acoustic signal level re-initialization is being performed before Search mode is entered.
Search	Sensor card is looking for an acoustic resonance to track/measure. (Frequency, Amplitude, R2 and RAV should be ignored while in Search mode.)
Track	Sensor card is tracking/measuring a resonance.
QTrack	Sensor card is tracking a resonance, but due to its rapid changes, the higher slew rate QTrack is being used for measurement. While in QTrack mode: ◆ Frequency and amplitude will usually change rapidly ◆ RAV will increase due to frequency change ◆ R2 and Error should be ignored

3.3.2.7 Sensor Parameters Screen

The **Sensor Parameters** screen displays all available settings for a given sensor: See Figure 3-7.

Figure 3-7 Sensor parameters screen



Use the control knob to move between parameters, then press **Edit** to edit the highlighted parameter. Refer to section 3.1.1 on page 3-1 for information on how to enter and edit parameters. **Overview** displays the **Overview** screen. **Back** will display the **Sensor** screen.

Allow user zero . . . . Is a user-defined reference zero allowed? Default value is No.

Temperature Setpoint 1 . . . . Sets the Acoustic Sensor's resonant chamber temperature (°C). Allowable range is 30.0 to 65.0°C. Default is 40°C.

Temperature Setpoint 2 . . . . Temperature setpoint (°C) of the inlet tube. Allowable range is 30.0 to 68.0°C. Will default to 3°C higher than **Temperature Setpoint 1** when **Temperature Setpoint 1** is updated.

Carrier MOL Weight . . . . Molecular weight of the lighter (or carrier) gas. Allowable range is 1.000 - 1000.000. Default is 28.01.

Carrier Gamma . . . . Specific heat ratio of the lighter (or carrier) gas. Allowable range is 1.000 - 2.000. Default is 1.400.

Precursor MOL Weight . . . . Molecular weight of the heavier (or precursor) gas. Allowable range is 1.000 - 1000.000. Default is 159.93.

Precursor Gamma . . . . Specific heat ratio of the heavier (or precursor) gas. Allowable range is 1.000 - 2.000. Default is 1.076.

Sample Averaging Depth. . . . . Number of frequency readings to be averaged together. A value of 0 or 1 indicates no averaging. Allowable range is 0 - 100. Default is 0.

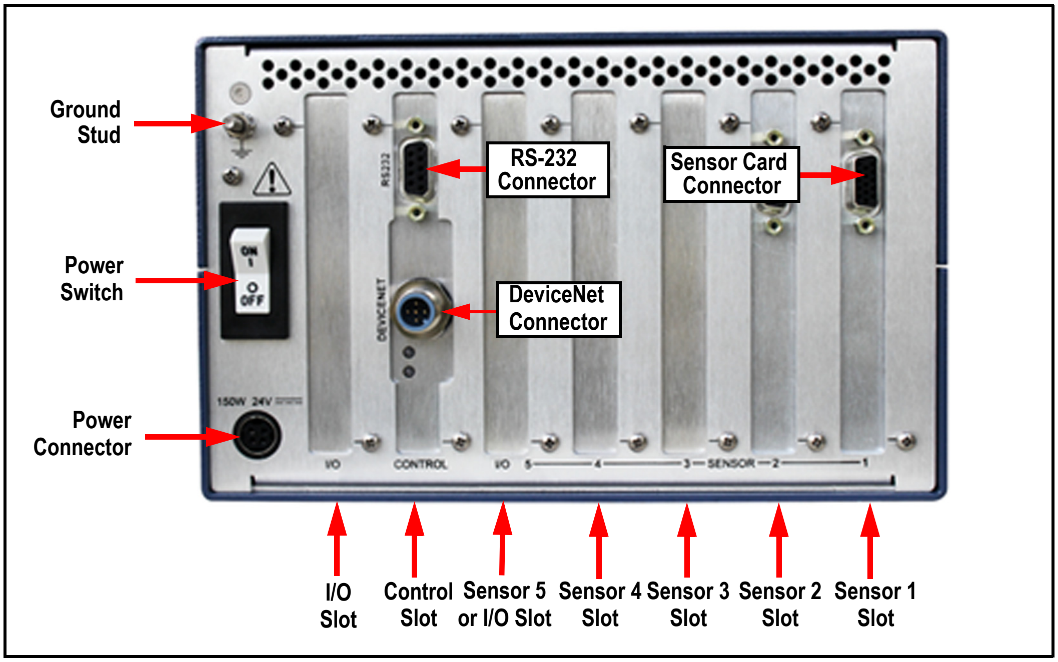
CAUTION

Set the Composer Elite Acoustic Sensor resonant chamber temperature (Temperature Setpoint 1) 5°C above process gas tubing temperature. This is to ensure precursor gas does not condense inside the Acoustic Sensor. However, if this temperature is too close to the ambient temperature, it may be difficult to maintain Temperature Setpoint 1. Setting higher values for Temperature Setpoint 1 and 2 will remedy this situation.

3.3.3 Description of Rear Panel

The rear panel of Composer Elite is shown in Figure 3-8.

Figure 3-8 Rear panel of Composer Elite



3.3.3.1 Power Connector

A 4-pin connector used for connection to a 24 V(dc) power supply. Refer to section 1.5.4, Power Supply, on page 1-11 for a full description of the power supply requirements and pin connections.

3.3.3.2 Power Switch

The power switch is set to ON (I) to power up Composer Elite and it is set to OFF (O) to power down Composer Elite.

NOTE: The power switch is a circuit breaker rated at 7.5 A. The circuit breaker will trip on a current overload condition, even if forcibly held in the ON (I) position.

3.3.3.3 Ground Stud

The M4 ground stud is used for establishing an electrical ground to the Sensor Control Unit. (Refer to section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4.)

3.3.3.4 I/O Slot

Reserved for future use.

3.3.3.5 Control Slot

This slot is occupied by the Control card. RS-232 and DeviceNet connectors are located on the rear panel of the Control card (see Chapter 5, Remote Communications for information regarding RS-232 and DeviceNet).

3.3.3.6 Sensor 5 - I/O Slot

This slot is currently available only for an additional Sensor card.

3.3.3.7 Sensor Slots 1 - 4

These slots are reserved for the Sensor card(s). Depending on a Sensor Control Unit's configuration, one to four slots are occupied by Sensor card(s). A 15-pin high-density D-sub connector used for interfacing Sensor cards to Acoustic Sensors is located on the rear panel of the Sensor card (refer to section 2.2.3, Installing Interconnect, Power Supply, and Communications Cables, on page 2-11).

Chapter 4
Applications Guide

4.1 Advice and Tips

The following paragraphs review many common questions encountered during setup and operation.

4.1.1 What is the Required Warm Up Time?

Once the setpoint for the Acoustic Sensor's temperature is altered, it will take up to thirty minutes for a single Acoustic Sensor's temperature to settle around the operating point. It may take even more time if the temperature setpoint is lowered and is close to the ambient temperature (refer to section 2.1.1.3, Heated Process Tubing and Acoustic Sensor Temperatures, on page 2-2).

Once the setpoint temperature is reached, Composer Elite is ready to provide data. It is our experience that because of the relatively low thermal conductivity of the materials used to construct the Resonant Chamber, even after an hour there is still some small potential to further reduce temperature induced speed of sound measurement errors. It is easy to reset the Reference Zero frequency and eliminate these effects (refer to section 3.2, Calibration, on page 3-2).

It is also expected that the Acoustic Sensor will always be operating, minimizing day-to-day variations because any long term thermal settling complications will be absent. If the ambient temperature changes, there may be some slight variation on the temperature of the Resonant Chamber as the effective thermal load changes. This can be ignored except for the most precise measurements and over the most extreme temperature swings.

4.1.2 When and How Often to Set the Reference Zero

Normal operation will be enhanced by daily Calibration to set Reference Zero (refer to section 3.2, Calibration, on page 3-2). This mitigates any effects of slight variations in day-to-day process tubing pressure and atmospheric pressure changes. If the frequency of the Reference Zero is recorded every day, a record of Composer Elite performance is generated. This makes it easy to determine if a mistake has been made due to careless procedure by comparison to the previously recorded values. It would be unusual for Composer Elite's daily Reference Zero frequency to vary by more than about 0.2 Hz for nitrogen and 0.8 Hz for hydrogen.

Calibration should be immediately performed any time the pressure, flow rate or any other Composer Elite subsystem such as a Mass Flow Controller, Back Pressure Controller or pressure gauge is changed — even if it is the same type and uses the same settings.

The correct (user set) Reference Zero is retained until a new Reference Zero is established, the Setpoint Temperature is changed or new carrier gas parameters are entered.

NOTE: **STEADY** and **AT TEMP** must be visible when completing the Calibration process. This indicates the measurement conditions are stable and a relative equilibrium has been reached. It sometimes takes many minutes for the light (low molecular weight) carrier gas to clean the Resonant Chamber of any residual Precursor or other heavy gases. Remember that some gases may also absorb on the Resonant Chamber's walls and are slowly released, further extending the time to reach pure carrier gas as indicated by stable frequency.

CAUTION

Setting Zero Reference before the Resonant Chamber is completely purged of precursor gas will result in an offset and scaling error in the measured concentration. See section 4.1.10 on page 4-8.

4.1.3 How is Performance Affected by using the Factory Zero Value?

While it is most accurate to reset Reference Zero daily, excellent results can be obtained for many processes by using the Factory Zero value for Reference Zero. While the exact loss of reproducibility is hard to predict, it is reasonable that it will be about two to four times worse than the specified value when monitored over extended periods of time. This may be acceptable, and convenient, for the process.

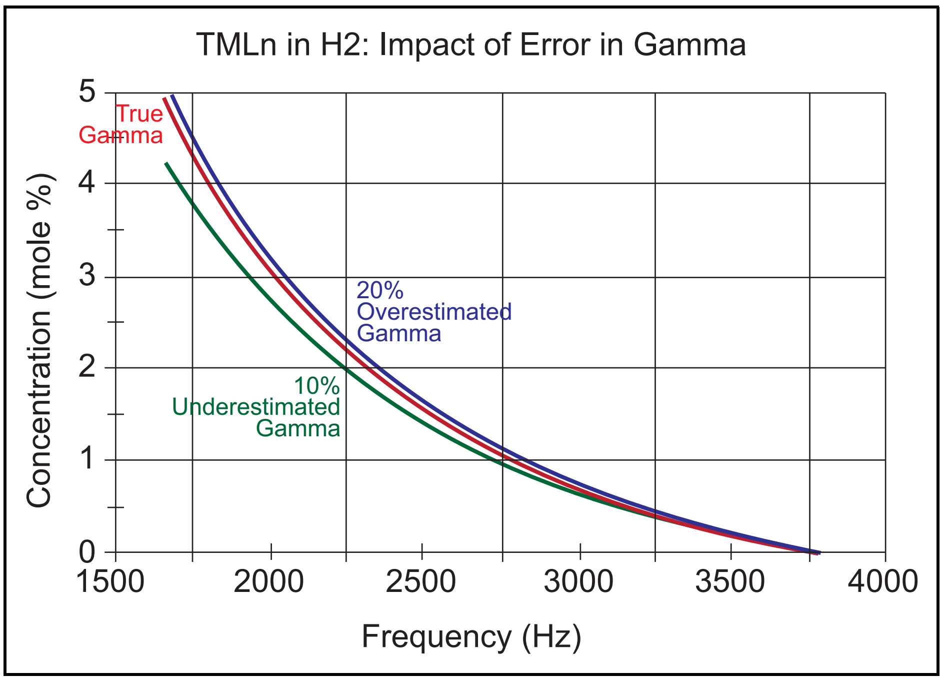
Alternating between the Factory Zero and carefully setting the Reference Zero occasionally will not be productive. It would be better to extend the interval between reestablishing the Reference Zero than to alternate. An example of long term stability is shown in section 4.1.9 on page 4-7.

4.1.4 What To Do when the Specific Heat Ratio for a Gas is Unknown

Quantitative accuracy for an acoustic measurement technique partially depends on accurate knowledge of the Specific Heat Ratio, γ, of the individual gas species. While this ratio is known for many pure common gases, little information is available on many of the complex Precursor molecules. The information currently available is given in Table B-1 on page B-1. Even without exact knowledge of the Specific Heat Ratio, useful information and reliable operation can still be obtained. The Specific Heat Ratio of gases is a parameter that does not have a large range, it is confined to a range of about 1.1 to 1.7 for almost every known gas. Consequently, using the wrong Specific Heat Ratio will not make a significant error in most cases. It is also possible to make intelligent guesses about unknown gases using the value of the Specific Heat Ratio for a similar gas. It is almost always more accurate to overestimate the Specific Heat Ratio than to underestimate by the same amount; see Appendix B and Figure 4-1. Consider also that in production, accuracy is not as important as the reproducibility. As long as the Specific Heat Ratio is not changed, Composer Elite will produce similar results, day after day.

NOTE: Long term use of Composer Elite with some of the materials listed in Appendix B may not be possible.

Figure 4-1 When the specific heat ratio for a gas is unknown it is generally better to overestimate the specific heat ratio



4.1.5 What is the Ideal Operating Environment?

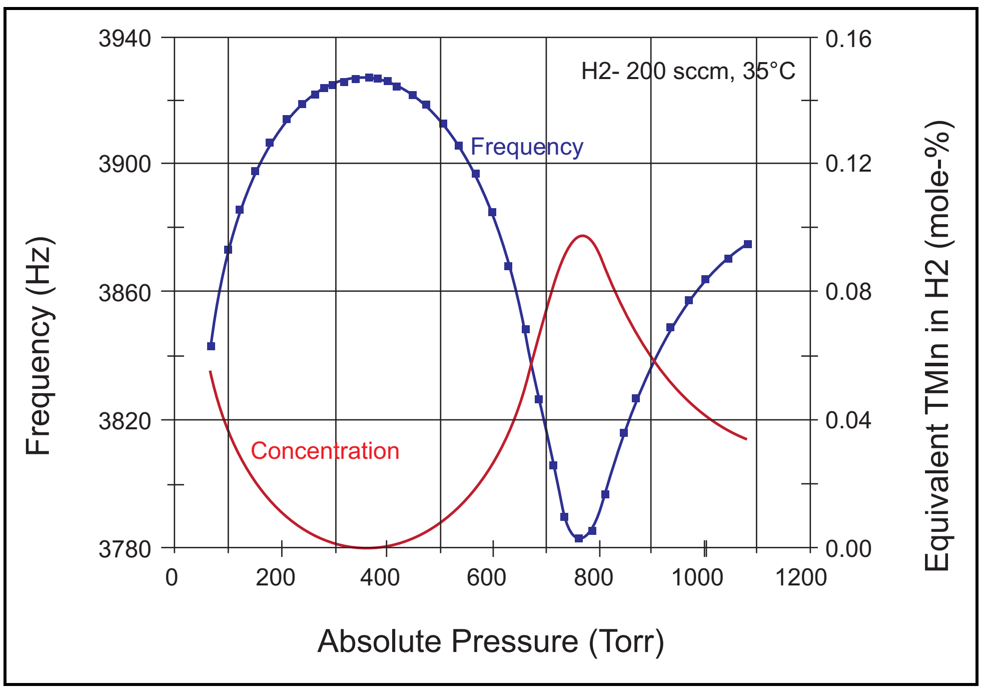
In an ideal operating environment, parameters that influence the concentration measurement do not change. Most Reactors can be configured so that the pressure and flow through the Acoustic Sensor are held constant by independent controllers. The precursor's fluence into the Reactor can be maintained or changed without altering the total flow and pressure through the Acoustic Sensor. This is considered good practice for Reactor design.

Leave the Composer Elite System on at all times—always ready to immediately function with best accuracy. We have not seen deterioration through continuous use. Since all Reactors are in environmentally controlled rooms, the small influences due to ambient temperature changes are of no concern.

4.1.6 What is the Effect of Pressure Variation?

Because not all mixtures are purely ideal and the use of diaphragms to separate the toxic and corrosive gases from the Exciting and Receiving microphones is required, Composer Elite displays a small influence from pressure changes. The effects of pressure variation on concentration are shown in Figure 4-2.

Figure 4-2 Effect of pressure on apparent concentration



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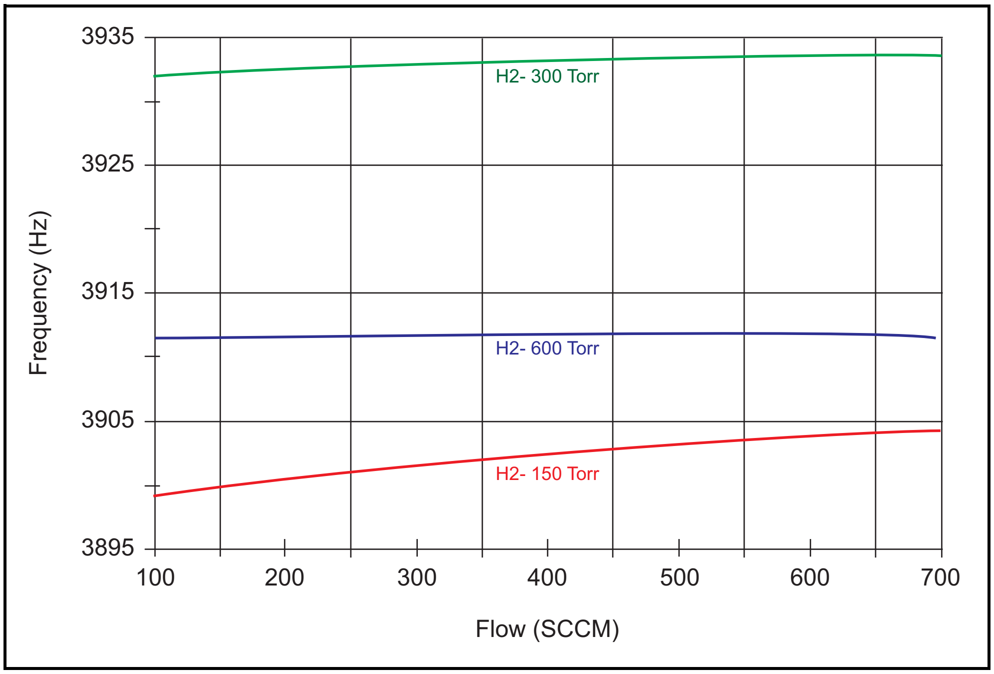
4.1.7 What is the Effect of Flow Variation?

There is virtually no flow induced effect on concentration measurement in the Composer Elite System except at the highest flow rates, see Figure 4-3, the pressure drop across the Acoustic Sensor is about 12 Torr [1.60 kPa] at 2000 sccm for the Standard sensor or 6 Torr [0.80 kPa] for the High Flow sensor.

HINT: Large variations in flow rate will cause a shift in the zero concentration point. To minimize zero shift due to flow rate change, carefully set the inlet tubing heater temperature (Temperature Setpoint 2). The default value for Temperature Setpoint 2 is 3 degrees higher than Temperature Setpoint 1. Adjusting the Temperature Setpoint 2 value slightly might be necessary depending on your process requirements.

Figure 4-3 Effect of flow on apparent concentration



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4.1.8 How Does This Instrumental Method Differ from Measuring the Speed of Sound by Time of Flight?

The use of a low frequency Resonant Chamber has significant advantages over Time of Flight (TOF) methods. It allows the constructive build up of energy within the Resonant Chamber. Plus, sound transmission in hydrogen at low frequency is more efficient than at high frequency. This enhances the instrument's ability to measure concentration in hydrogen mixtures at lower pressures. Finally, the careful intelligent manipulation of the applied frequency around the resonant amplitude peak allows even greater precision in the determination of the speed of sound. The resonant method does not lose accuracy because of uncertainty of guessing when the center of a low energy acoustic pulse packet precisely leaves the Sender and reaches the Receiver. See Figure 4-4.

For a TOF instrument to achieve resolution equivalent to Composer Elite (1 part in 50,000), it must achieve time measurement precision of 3 nanoseconds. This resolution is achievable for sophisticated instruments measuring photons or particles, but is approximately forty times better than the resolution possible on the poorly defined 15 kHz ultrasonic wave pulse in hydrogen. One wavelength of a 15 kHz tone is 0.0856 m, almost one half the length of a 0.2 m path length instrument.

4.1.8.1 Calculation Example

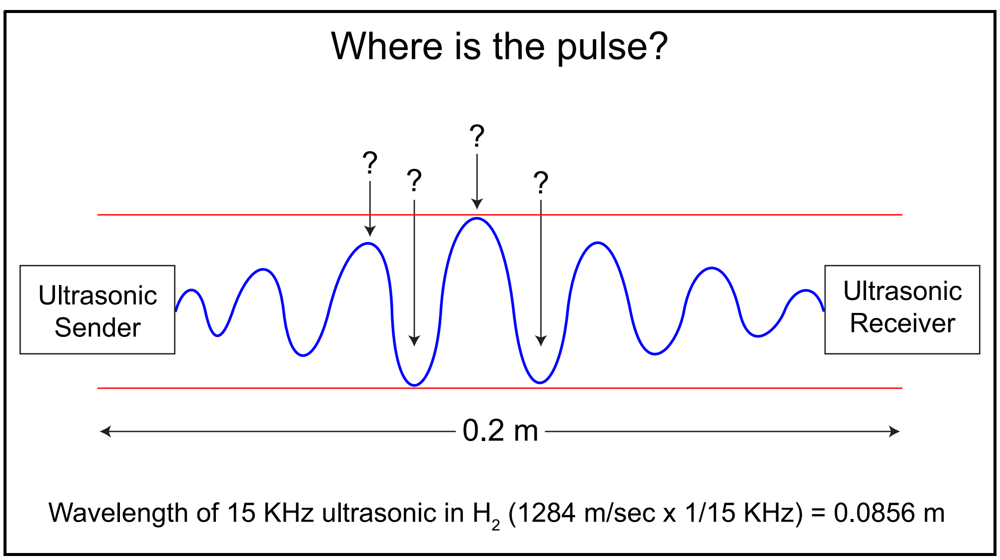
The time interval for an acoustic pulse to travel 0.2 meters in hydrogen is computed as follows (see equation [1] and Figure 4-4)

NOTE: The speed of sound in hydrogen is 1284 meters/second.

$$\frac{0.2\text{ m}}{1284\text{ m/s}} = 1.56\text{ E-4 s transit time} \qquad [1]$$

In order to achieve equivalent resolution to the Composer Elite resonant technique, the TOF instrument's ability to measure the pulse must be 1/50,000 of the transit time, or: 1.56 E-4 (1/50,000) = 3.12 E-9 seconds

Figure 4-4 Where does the pulse begin or end?



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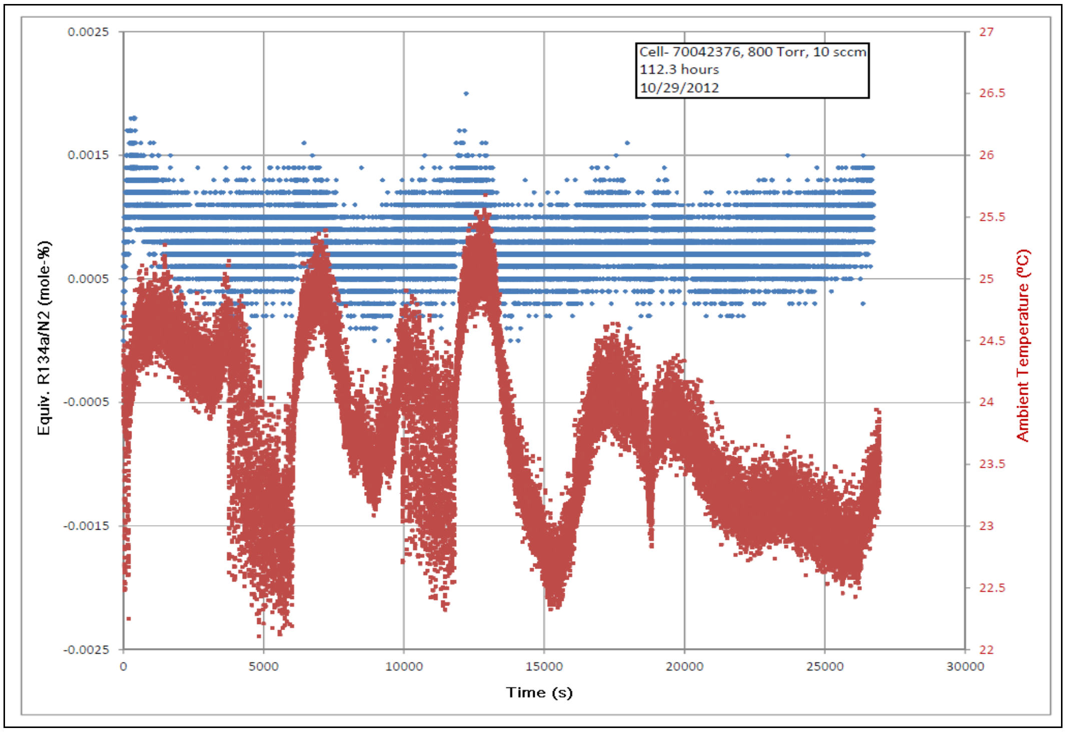
4.1.9 What is the Long Term Stability of this Measurement System?

There does not appear to be any trend that might lead to any unexpected wear or degradation with time. This data is not corrected for zero offsets due to atmospheric pressure variations over the test period.

Using R134a in nitrogen as a test (R134a is similar in molecular weight to some common metal organic precursor gases), the chart shown in Figure 4-5 shows stability of +/- 5 ppm over 112 hours, even as the ambient temperature varies by 3°C. This is equivalent to <1 ppm trimethylIndium in hydrogen.

Figure 4-5 Long term reproducibility and stability at low pressure

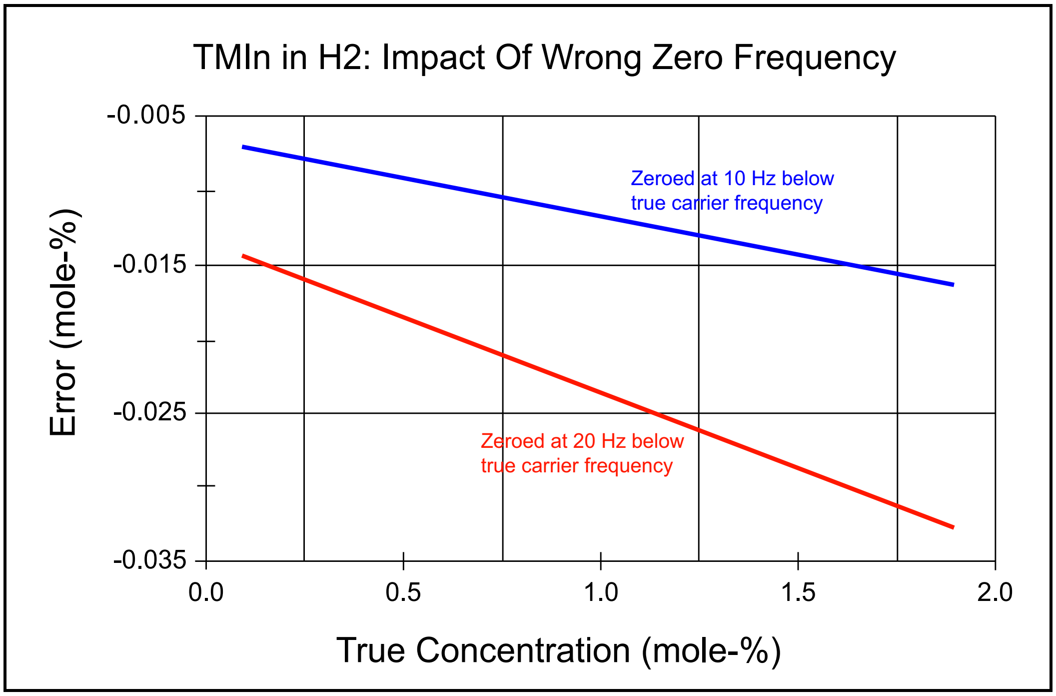


4.1.10 What Happens if the Reference Zero is Improperly Set?

If the Reference Zero is set when the conditions are wrong, i.e., not completely purged of precursor gas:

1. A permanent concentration offset is introduced equal to the residual precursor concentration when the new Reference Zero is applied. This is not corrected until a proper Reference Zero is performed.
2. The sensitivity is altered, leading to an error proportional to the concentration.

Figure 4-6 Impact of wrong zero frequency



NOTE: Factory Zero will be restored if one of the carrier gas parameters (molecular weight or γ) is altered or if **TEMP 1 Setpoint** is changed or if **Allow User Zero** is changed from **Yes** to **No**.

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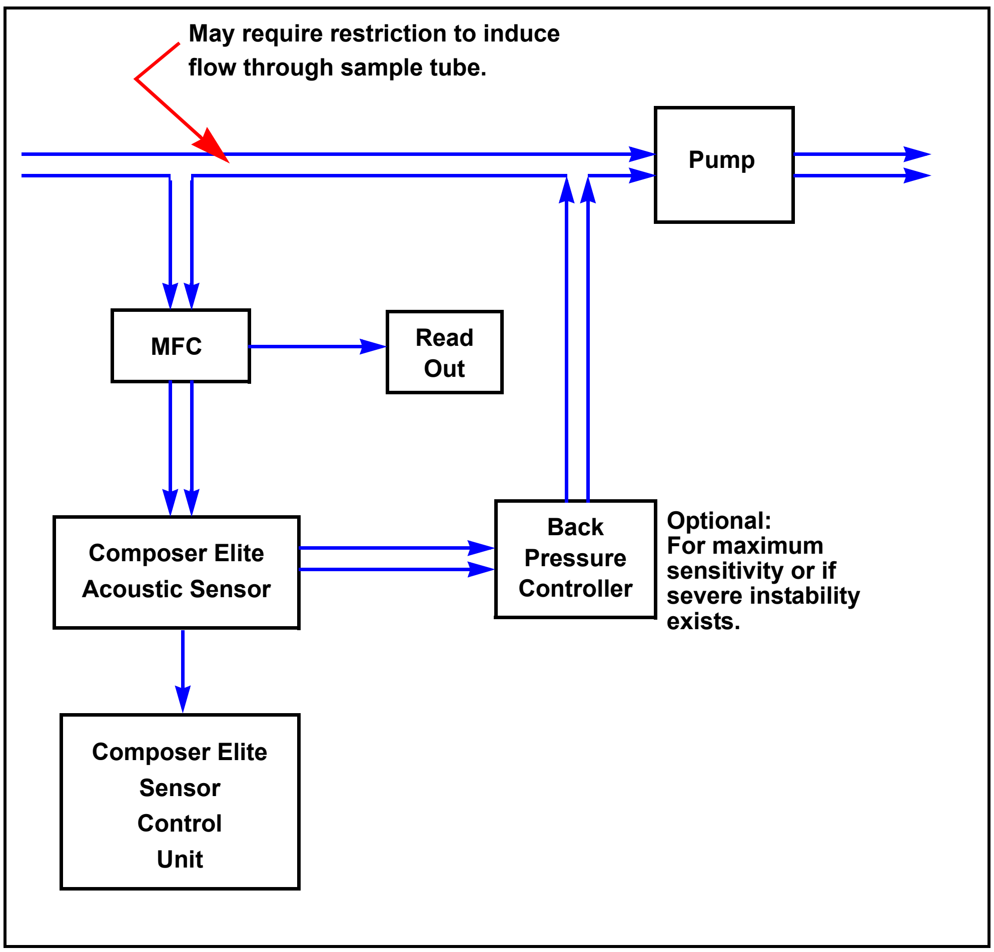
4.1.11 How to Sample Flow with a Composer Elite

When the flow through a process pipe exceeds the Acoustic Sensor's 2000 sccm limit, sampling of the process is required. In our experience, bypassing some of the process gas through the Acoustic Sensor can compromise Composer Elite precision, long term accuracy and add noise due to pressure and flow fluctuations.

Our recommendation is to "buffer" the flow through the Acoustic Sensor by adding a Mass Flow Controller (MFC) upstream of the Acoustic Sensor in the sample tubing. This device will stabilize the flow and in most cases restore Composer Elite full measurement capability. In some extreme cases it may be necessary to also add downstream buffering with a Back Pressure Controller. Try to maintain at least 200 Torr [26.66 kPa] in the Acoustic Sensor for best operation. It may be necessary to slightly restrict the process tubing in order to induce flow through the sample tube. See Figure 4-7.

An added benefit of adding the MFC to the sample tube is that flow through the Acoustic Sensor is made visible and easily verified.

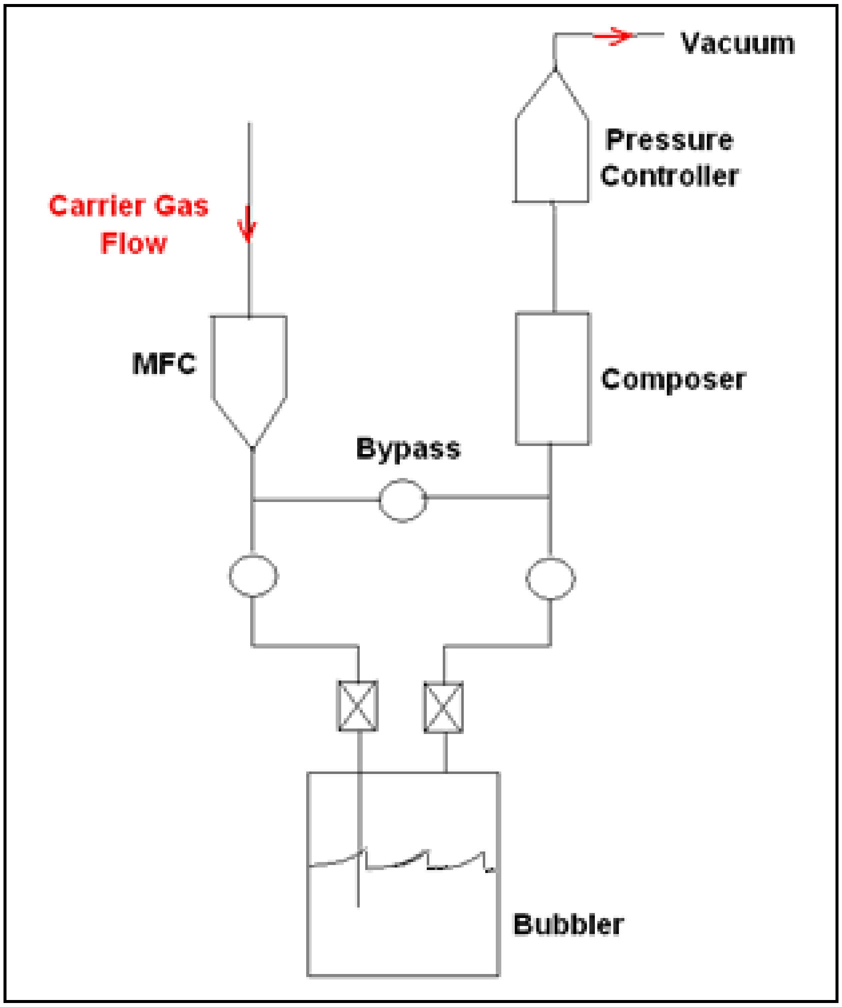
Figure 4-7 Flow sampling



4.1.12 What would cause periods of oscillation in the concentration?

A decaying oscillation in concentration reading given constant conditions is likely due to a pressure/flow control issue. This will most likely be the case if this is seen at higher pressures and if warning 13 and 15 are received. The following describes one method of addressing this issue on a typical CVD system (as shown in Figure 4-8.)

Figure 4-8 Typical MOCVD System



To troubleshoot, flow the carrier gas and bypass the bubbler, to see if the Composer Elite is working correctly throughout the specified pressure range. If the issue does not occur and the bubble needs to be present, try opening all valves (except for the bypass valve) and control the pressure/flow only from the pressure controller furthest downstream and not via the Mass Flow Controller (MFC.)

Material may build up on the valves causing them to be unable to completely close or open. Normally, the pressure controller will start to show fluctuations when this happens but the sensitivity of the CE may be greater than that of the pressure controller so, it can potentially detect this need for system maintenance before the pressure controller would.

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Finally, note that the pressure & mass flow controller opening and closing sequence is not perfect so this would also affect the pressure stability. The Acoustic Sensor is designed for static operation. Allow the system time to stabilize.

NOTE: This section is given as a general troubleshooting aid and assumes user knowledge of the overall system operation. Consult the system manufacturer for a more detailed troubleshooting approach.

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Chapter 5
Remote Communications

5.1 Introduction

Composer Elite supports RS-232C and DeviceNet communications, and may be remotely controlled, programmed or interrogated. This is accomplished through remote communications and the use of a remote command set. Composer Elite will respond to messages that contain these commands. It will accept and operate one message at a time. It will respond to each command by carrying out valid operations and/or returning a message to the sender. A host/server relationship is established in remote communications. Composer Elite, as server, responds to the remote host's commands.

5.2 General Type Definitions for Remote Communications

General Type Definitions

<Float> = 4 byte, single precision ANSII standard floating point, low to high

<String> = Variable length, null terminated ASCII characters

<Byte> = 1 Byte

<Encode> = 4 Byte, low to high

<Short> = 2 Bytes, low to high

<Integer> = 4 Bytes, low to high

NOTE: All data elements larger than a byte are in little-endian form, both those sent and returned.

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5.3 RS-232 Communications

For RS-232 communications, an industry standard 9-pin D-sub-miniature connector is required to connect to Composer Elite. See Figure 5-1 and Table 5-1.

Both the host and server must have the same form of communications equipment and complementary set up. For serial communications, baud rates must match and so must the data word format. Hardware handshaking is not supported.

The word format for bit serial lines (RS-232C) is comprised of ten signal bits: eight data bits, one start bit, one stop bit and no parity.

The eight data bits comprise a byte of information or character whose ASCII value ranges from 0 to 255.

The length of the cable is limited to 15.2 m (50 ft.).

Only serial communications baud rate of 115,200 is supported.

The communications interface operates using the DCE (Data Communications Equipment) configuration.

NOTE: Some RS-232 hardware/software combinations may occasionally cause a command to not be recognized by Composer Elite. Consequently, all communications should include an automatic retry procedure if a response is not received within three seconds.

CAUTION

RS-232 uses single-ended signaling with all signals sharing a common ground, making it susceptible to cross-talk and noise if the RS-232 cable is not properly shielded and not routed away from sources of noise. A very high data rate can overwhelm the internal buffers of the computer, resulting in data loss. Computer configuration (such as a power setting that allows the computer to sleep during a run) can cause data loss. Data loss can occur due to issues inherent to the Windows operating system, including the diversion of computer resources when Windows Automatic Update or antivirus software checks for updates on the Internet.

Figure 5-1 9-pin type “D” female connector

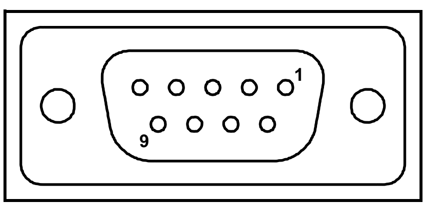

Table 5-1 RS-232C 9-pin type "D" connector pin connections

Pin#	Description	DB9*	DB25**
1	Not Used	1	-
2 TXD	Data transmitted by the Sensor Control Unit	2	3
3 RXD	Data received by the Sensor Control Unit	3	2
4 DSR	Not Used	4	-
5 GND	Signal Ground	5	7
6 DTR	Not Used	6	6
7 CTS	Not Used	7	4
8 RTS	Not Used	8	-
9 GND	Not Used	9	-
*Host **IBM compatible computer connector			

5.4 DeviceNet Communications

For DeviceNet Messaging, the transmit/receive message count field is used by the process transmitting the message to indicate that data is available to read and process.

The application will populate the Composer Elite command field with the data to be transmitted to Composer Elite and increment the **Transmit Message Count** field. This will indicate to Composer Elite that there is a command ready to be processed.

Composer Elite constantly monitors the value in the **Transmit Message Count** field. When Composer Elite detects a change in the value of the count field, it will process the command and put the response in the Composer Elite Response field and increment the **Receive Message Count** value.

The application will periodically read the **Receive Message Count** field for a change in the count. When a count is detected, this indicates to the application that Composer Elite has completed processing the command sent and a response is in the Composer Elite Response field.

Upon initialization, the application must read the **Receive Message Count** field and use it as its initial receive/transmit count values. The transmit message count must be given ahead of the desired command message. Responses, on DeviceNet, will also be preceded by a receive byte count.

NOTE: DeviceNet communications used with Composer Elite Multi-Sensor Software must be used with a Beckhoff FC5201 DeviceNet computer Interface card.

The DeviceNet cable requires 24 volts. This voltage is not supplied by the Sensor Control Unit. If the Beckhoff FC5201 DeviceNet computer interface card does not detect 24 volts, it will not work and flag an error.

If remote communications are used, any DeviceNet device will be suitable for DeviceNet communications.

CAUTION

DeviceNet communications over a single bus can allow data to be inadvertently sent and received simultaneously, resulting in the loss of that particular data set (this is not an issue when using the Composer Elite’s full-duplex RS-232). A very high data rate can overwhelm the internal buffers of the computer, resulting in data loss. Computer configuration (such as a power setting that allows the computer to sleep during a run) can cause data loss. Data loss can occur due to issues inherent to the Windows operating system, including the diversion of computer resources when Windows Automatic Update or antivirus software checks for updates on the Internet.

5.4.1 DeviceNet Objects

5.4.1.1 CIP Type Definitions

Refer to ODVA™ CIP™ classes.

5.4.1.2 Identity Objects (01h)

Table 5-2 shows the Identity objects. The supported services are:

- Class - Get Attribute Single (Revision, UINT, 0001h)
- Instance - Get Attribute Single, Reset

Table 5-2 Instance #1 Attributes (Identity Object)

#	Name	Access	Type	Comments
1	Vendor ID	Get	UINT	0279h
2	Device Type	Get	UINT	000Ch (Communications Adapter)
3	Product Code	Get	UINT	003Dh
4	Revision	Get	Struct. of {USINT, USINT}	Major, Minor Controller Firmware Version
5	Status	Get	WORD	Bit 0 = Module Owned Bit 1 = (reserved) Bit 2 = Configured Bit 3 = (reserved) Bits 4-7 = Extended Device Status 0000b = unknown 0001b = Faulted I/O Connection 0010b = No I/O Connection est. 0011B = Non-volatile config. Bad 0110b = Connection in Run mode 0111b = Connections in Idle mode Bit 8 = Set for minor recoverable faults Bit 9 = Set for minor unrecoverable faults Bit 10 = Set for major recoverable faults Bit 11 = Set for major recoverable faults Bits 12-15 = reserved
6	Serial Number	Get	UDINT	Unique Number
7	Product Name	Get	Short String	"Composer Elite"

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5.4.1.3 Message Router (02h)

Not used.

5.4.1.4 DeviceNet Object (03h)

DeviceNet objects are shown in Table 5-3. The supported services are:

- Class - Get Attribute Single (Revision, UINT, 0002h)
- Instance - Get/Set Attribute Single, Allocate Master/ Slave Connection Set (4Bh), Release Group 2 Identifier Set (4Ch)

Table 5-3 Instance #1 Attributes (DeviceNet Object)

#	Name	Access	Type	Comments
1	MAC ID	Get/Set(a)	UINT	Currently used MAC ID
2	Baud Rate	Get/Set(a)	UINT	Currently used Baud Rate 0 = 125 kbps 1 = 250 kbps 2 = 500 kbps
3	BOI	Get/Set	UINT	False
4	Bus Off Counter	Get	USINT	00h
5	Allocation Information	Get	Struct. of: BYTE, USINT	(BYTE) Allocation of choice byte (USINT) MAC ID of master
10	Quick Connect	Get/Set	BOOL	(True) Disable Quick Connect (default) (False) Enable Quick Connect
100	Disable Auto Baud (b)	Set	BOOL	(True) Disable Auto Baud (default) (False) Enable Auto Baud

(a) Attribute may not be able to be set if configuration does not allow it.
(b) This setting is stored in non-volatile memory.

5.4.1.5 Assembly Object (04h)

This assembly object uses static assemblies and holds the Composer Elite I/O. The assembly instance IDs used are in the vendor specific range. Specifics on the CE Out(Command) and CE IN(Response) are detailed later in the section 5.5.1, Command, on page 5-22 and section 5.5.2, Response, on page 5-22.

NOTE: This is the object used to interact with Composer Elite Command & Response messaging. This object can alternatively be used to publish data as selected by the I/O Data Format attribute in the I/O Data Format Object.

The supported services are:

- Class - None
- Instance - Get/Set Attribute Single

Table 5-4 Instance 64h Attribute (Producing Instance)

#	Name	Access	Type	Comments
3	CE Message	Get	Array of byte	Data Corresponds to Composer Elite Input (CE IN)

Table 5-5 Instance 96h Attribute (Consuming Instance)

#	Name	Access	Type	Comments
3	CE Message	Set	Array of byte	Data Corresponds to Composer Elite output (CE OUT)

5.4.1.6 Connection Object (05h)

Connection objects are shown in Table 5-6.

The supported services are:

- Class - Get Attribute Single (Revision, UINT, 0001h)
- Instance - Get/Set Attribute Single

Table 5-6 Instance #1,#10...#14 (Explicit Messaging)

#	Name	Access	Type	Comments
1	State	Get	USINT	0 = Nonexistent 1 = Configuring 2 = Waiting for Connections ID 3 = Established 4 = Timeout 5 = Deferred Delete
2	Instance Type	Get	USINT	0000h (explicit messaging type)
3	Transport Class Trigger	Get	BYTE	83h (Server, Transport class 3)
4	Produced Connection ID	Get	UINT	-
5	Consumed Connection ID	Get	UINT	-
6	Initial Comm Characteristics	Get	BYTE	21 = Instance#1 33 = Instance #10..#14
7	Produced Connection Size	Get	UINT	262
8	Consumed Connection Size	Get	UINT	262
9	Expected Packet Rate	Get/Set(a)	UINT	2500ms
12	Watchdog Timeout Action	Get/Set(a)	USINT	0001h = Auto Delete (default) 0003h = Deferred delete
13	Produced Connection Path Length	Get	UINT	0000h (No connection path)
14	Produced Connection Path	Get	EPATH	-
15	Consumed Connection Path Length	Get	UINT	0000h (no connection path)
16	Consumed Connection Path	Get	EPATH	-
17	Production Inhibit Time	Get	UINT	0000h
(a) Not able to be set on UCMM explicit message connections (Instance 10...14)				

Table 5-7 Instance #2 (Poll or "COS/Cyclic Consuming")

#	Name	Access	Type	Comments
1	State	Get	USINT	0 = Nonexistent 1 = Configuring 2 = Waiting for Connections ID 3 = Established 4 = Timeout
2	Instance Type	Get	USINT	0000h (I/O Connection)
3	Transport Class Trigger	Get	BYTE	82h = Server, Polled, Class 2 80h = Server, COS/Cyclic, Class 0, No Ack. 82h = Server, COS/Cyclic, Class 2, Ack.
4	Produced Connection ID	Get	UINT	FFFFh = Not Consuming (COS/Cyclic) Other = CAN ID for transmission
5	Consumed Connection ID	Get	UINT	-
6	Initial Comm Characteristics	Get	BYTE	01h = Polled - Produces over message, group 1 - Consumes over message, group 2 F1h = COS/Cyclic, No Ack. - Consumes over message, group 2 01h = COS.Cyclic, Ack. -Produces over message, group 1 - Consumes over message, group2
7	Produced Connection Size	Get	UINT	0000h = COS/Cyclic other = Size of Fieldbus Input data (polled)
8	Consumed Connection Size	Get	UINT	Size of Fieldbus Output data
9	Expected Packet Rate	Get/Set(a)	UINT	-
12	Watchdog Timeout Action	Get/Set(a)	USINT	0000h (Transition to the timed out state)
13	Produced Connection Path Length	Get	UINT	0000h (COS/Cyclic) 0007h (Polled)
14	Produced Connection Path	Get	EPATH	No Value (COS/Cyclic) 20 04 25 64 00 30 03h (polled)
15	Consumed Connection Path Length	Get	UINT	0007h
16	Consumed Connection Path	Get	EPATH	20 04 25 96 00 30 03h
17	Production Inhibit Time	Get	UINT	0000h

Table 5-8 Instance #3 (Bit-Strobe)

#	Name	Access	Type	Comments
1	State	Get	USINT	0 = Nonexistent 1 = Configuring 2 = Waiting for Connections ID 3 = Established 4 = Timeout
2	Instance Type	Get	USINT	0001h (I/O Connection)
3	Transport Class Trigger	Get	BYTE	82h (Transport class and Trigger Server, Cyclic, Class 2)
4	Produced Connection ID	Get	UINT	-
5	Consumed Connection ID	Get	UINT	-
6	Initial Comm Characteristics	Get	BYTE	Produces over message, group 1 Consumes over message, group 2
7	Produced Connection Size	Get	UINT	0...8 bytes depending in Fieldbus Input size
8	Consumed Connection Size	Get	UINT	0008h
9	Expected Packet Rate	Get/Set(a)	UINT	-
12	Watchdog Timeout Action	Get/Set(a)	USINT	0000h (Transition to the timed out state)
13	Produced Connection Path Length	Get	UINT	0007h
14	Produced Connection Path	Get	EPATH	20 04 25 64 00 30 03h
15	Consumed Connection Path Length	Get	UINT	0007h
16	Consumed Connection Path	Get	EPATH	20 04 25 96 00 30 03h
17	Production Inhibit Time	Get	UINT	0000h

Table 5-9 Instance #4 (COS/Cyclic Producing)

#	Name	Access	Type	Comments
1	State	Get	USINT	0 = Nonexistent 1 = Configuring 2 = Waiting for Connections ID 3 = Established 4 = Timeout
2	Instance Type	Get	USINT	0001h (I/O Connection)
3	Transport Class Trigger	Get	BYTE	00h = Client, Cyclic, Class 0, No Ack. 10h = Client, COS, Class 0, No Ack. 02h = Client, Cyclic, Class 2, Ack. 12h = Client, COS, Class 2, Ack.
4	Produced Connection ID	Get	UINT	CAN ID for Transmission
5	Consumed Connection ID	Get	UINT	FFFFh = No Ack. Other = CAN ID for reception (Ack.)
6	Initial Comm Characteristics	Get	BYTE	0Fh = Producing only over message, group 1 (No Ack.) 01h = Produces over message, group 1 - Consumes over message, group 2 (Ack.)
7	Produced Connection Size	Get	UINT	Corresponds to Fieldbus Input size
8	Consumed Connection Size	Get	UINT	0000h (consumes 0 bytes on this connection)
9	Expected Packet Rate	Get/Set(a)	UINT	Timing associated with this connection
12	Watchdog Timeout Action	Get/Set(a)	USINT	0000h (Transition to the timed out state)
13	Produced Connection Path Length	Get	UINT	0007h
14	Produced Connection Path	Get	EPATH	20 04 25 96 00 30 03h
15	Consumed Connection Path Length	Get	UINT	0000h (No Ack.) 0005h (Ack.)
16	Consumed Connection Path	Get	EPATH	No Value (No Ack.) 20 2B 25 01 00h (Ack.)
17	Production Inhibit Time	Get	UINT	0000h

5.4.1.7 Acknowledge Handler Object (2Bh)

The supported services are:

- Class - Get Attribute Single (Revision, UINT, 0001h)
- Instance - Get/Set Attribute Single

Table 5-10 Instance Attribute (01h)

#	Name	Access	Type	Comments
1	Acknowledge Timer	Get/Set	UINT	16ms
2	Retry Limits	Get/Set	USINT	01h
3	Producing Connection Instance	Get	UINT	04h

5.4.1.8 I/O Data Format Object (64h)

The I/O Data Format Object is a vendor specific object used to determine how the contents of the Assembly Object buffers are formatted and used. The Composer Elite Output (CE OUT) and the Composer Elite Input (CE IN) can be used to exchange INFICON messages. Alternatively, the Composer Elite Output (CE OUT) can be used to cache a predefined set of data values.

Per the Composer Elite Cache Data Sets (see section 5.4.2, DeviceNet Data Sets, on page 5-12), all INFICON data sets are formatted per these byte tables and accessed via the Assembly Object (04h, Instance 96h). The Composer Elite will continuously update these data values as the values change. A change indicator in the form of a count field will be maintained to indicate when the values may have changed. Also, an update in progress indicator is given to indicate when a data set could be partially updated. The data set currently published is reported to help the host correctly interpret the data present.

NOTE: The data set functionality is only available when a Polled, COS, Cyclic or Bit Strobe connection is detected.

The supported services are:

- Class - None
- Instance - Get/Set Attribute Single

Table 5-11 Instance Attributes (01h)

#	Name	Access	Type	Comments
100	I/O Data Format	Get/Set	UINT	0 = INFICON Messaging 1 = Sensor 1 Data Set 2 = Sensor 2 Data Set 3 = Sensor 3 Data Set 4 = Sensor 4 Data Set 5 = Sensor 5 Data Set 6 = All 5 Sensor Card Data Set 7 = Sensors 1,2,3 Err/Wrn Data Set 8 = Sensors 4,5 Err/Wrn Data Set 9 = All 5 Sensor Card Concentration

5.4.2 DeviceNet Data Sets

5.4.2.1 Initialization

After a power cycle, Composer Elite will default to expecting and responding to INFICON messages. To instruct Composer Elite to cache data in CE OUT instead, in the host computer set the I/O Data Set attribute to a non-zero value. The value will specify to Composer Elite which data set to cache. This value can be changed. When Composer Elite is caching data to CE OUT, CE IN is not used.

NOTE: Switching data sets, or between INFICON messages and a data set, may take a few moments to complete.

5.4.2.2 Data

5.4.2.2.1 Data Sets

Data sets are preceded by a *Count*, an *Update In Progress* flag and a *Cached Data Set* value. The Cached Data Set value has been repeated in the following byte descriptions for improved clarity.

Table 5-12 Cached data sets values byte descriptions

	Value	Size (bits)	Field Type	Definition
Count	-----------	16	Short	Value that when monitored indicates when data values may have changed.
Update in Progress Flag	0-1	8	Byte	TRUE if the data values are being updated. FALSE otherwise. Used to determine if a partial value could be present.
Cache Data Set	1-9	9	Byte	Indicates how to interpret the following bytes of data.
Composer Elite Data Values	-----------	(N-3) * 8 bits	Byte	Data values. See Data Set tables.

5.4.2.2.2 Sensor 1-5 Data Set

All of the basic and advanced data associated with a single sensor. The data set can be requested for any of the 5 possible sensors.

Table 5-13 Sensor 1-5 data set

Name	Range	Data Type	Note
Cached Data Set	1-5	Byte	Byte
Boards Present Indicator	0 – 0x1F	Byte	Byte
SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Measurement Mode	IDLE = 0 READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.
Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.
Errors	------	Integer	Current error value. Refer to Table 5-22 for a complete description of the errors.
Warnings	------	Integer	Current warning value See Table 5-23 for a complete description of the warnings.
Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sample Number	0 – 255	Byte	The current sample number
Frequency		Float	
Amplitude		Float	
Heater 1 Current Drawn		Float	
Heater 2 Current Drawn		Float	
R Squared		Float	

Table 5-13 Sensor 1-5 data set (continued)

Name	Range	Data Type	Note
Standard Error		Float	
Q		Float	
PWM 1		Integer	
PWM 2		Integer	
Acoustic Gain		Byte	
D Gain Heater 1		Float	
I Gain Heater 1		Float	
P Gain Heater 1		Float	
D Gain Heater 2		Float	
I Gain Heater 2		Float	
P Gain Heater 2		Float	
RAV		Float	NOTE: RAV value is calculated during the Track and Q Track measurement modes. The RAV value will remain steady at the last RAV value calculated during the other measurement modes.
Controller Card Board Temperature		Float	
Sensor Card Board Temperature		Float	

5.4.2.2.3 All 5 Sensor Card Data Set

This data set returns a compound set of current data values for all five of the sensor cards.

Table 5-14 All sensor card data set

Name	Range	Data Type	Note
Cached Data Set	6	Byte	Numeric value of the data set cached.
Boards Present Indicator	0 – 0x1F	Byte	Bitwise: Bits 0 – 4 set indicate sensor board 1 – 5 present, respectively.
Sensor 1 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 1 Measurement Mode	IDLE = 0 READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Sensor 1 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 1 Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.

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Table 5-14 All sensor card data set (continued)

Name	Range	Data Type	Note
Sensor 1 Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.
Sensor 1 Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 1 Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 1 Sample Number	0 – 255	Byte	The current sample number.
Sensor 2 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 2 Measurement Mode	IDLE = 0 READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Sensor 2 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 2 Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.
Sensor 2 Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.
Sensor 2 Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 2 Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 2 Sample Number	0 – 255	Byte	The current sample number.

Table 5-14 All sensor card data set (continued)

Name	Range	Data Type	Note
Sensor 3 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 3 Measurement Mode	IDLE = 0 READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Sensor 3 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 3 Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.
Sensor 3 Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.
Sensor 3 Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 3 Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 3 Sample Number	0 – 255	Byte	The current sample number.
Sensor 4 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 4 Measurement Mode	IDLE = 0 READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Sensor 4 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 4 Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.
Sensor 4 Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.

Table 5-14 All sensor card data set (continued)

Name	Range	Data Type	Note
Sensor 4 Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 4 Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 4 Sample Number	0 – 255	Byte	The current sample number.
Sensor 5 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 5 Measurement Mode	IDLE = 0, READY =1 SEARCH = 2 TRACK = 3 QTRACK = 4 BASELINE = 6	Encoded	Current System Measurement Mode.
Sensor 5 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 5 Temperature 1	30.0 – 65.0 C	Float	The current temperature value of first temperature sensor.
Sensor 5 Temperature 2	30.0 – 65.0 C	Float	The current temperature value of second temperature sensor.
Sensor 5 Heater 1 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 5 Heater 2 Status	0 - 6	Short	0 = Off 1 = Not at temp 2 = At temp 3 = Failed 4 = Cable Disconnected 5 = Near Temp 6 = Over Temp
Sensor 5 Sample Number	0 – 255	Byte	The current sample number.

5.4.2.2.4 Sensors 1,2,3 Error/Warning Data Set

This data set returns a compound set of current data values for three of the five sensor cards.

Table 5-15 Sensors 1,2,3 error/warning data set

Name	Range	Data Type	Note
Cached Data Set	7	Byte	Numeric value of the data set cached.
Boards Present Indicator	0 – 0x1F	Byte	Bitwise: Bits 0 – 4 set indicate sensor board 1 – 5 present, respectively.
Sensor 1 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18 SS bit is not relevant in the data set format.
Sensor 1 Errors	------	Integer	Current error value Refer to Table 5-22 for a complete description of the errors.
Sensor 1 Warnings	------	Integer	Current warning value Refer to Table 5-23 for a complete description of the warnings.
Sensor 1 Sample Number	0 – 255	Byte	The current sample number.
Sensor 1 Frequency		Float	
Sensor 1 Amplitude		Float	
Sensor 1 Heater 1 Current Drawn		Float	
Sensor 1 Heater 2 Current Drawn		Float	
Sensor 2 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 2 Errors	------	Integer	Current error value. Refer to Table 5-22 for a complete description of the errors.
Sensor 2 Warnings	------	Integer	Current warning value Refer to Table 5-23 for a complete description of the warnings.
Sensor 2 Sample Number	0 – 255	Byte	The current sample number.
Sensor 2 Frequency		Float	
Sensor 2 Amplitude		Float	
Sensor 2 Heater 1 Current Drawn		Float	
Sensor 2 Heater 2 Current Drawn		Float	

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Table 5-15 Sensors 1,2,3 error/warning data set (continued)

Name	Range	Data Type	Note
Sensor 3 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 3 Errors	------	Integer	Current error value. Refer to Table 5-22 for a complete description of the errors.
Sensor 3 Warnings	------	Integer	Current warning value. Refer to Table 5-23 for a complete description of the warnings.
Sensor 3 Sample Number	0 – 255	Byte	The current sample number.
Sensor 3 Frequency		Float	
Sensor 3 Amplitude		Float	
Sensor 3 Heater 1 Current Drawn		Float	
Sensor 3 Heater 2 Current Drawn		Float	

5.4.2.2.5 Sensors 4,5 Error/Warning Data Set

This data set returns a compound set of current data values for two of the five sensor cards.

Table 5-16 Sensors 4,5 error/warning data set

Name	Range	Data Type	Note
Cached Data Set	8	Byte	Numeric value of the data set cached.
Boards Present Indicator	0 – 0x1F	Byte	Bitwise: Bits 0 – 4 set indicate sensor board 1 – 5 present, respectively.
Sensor 4 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 4 Errors	------	Integer	Current error value. Refer to Table 5-22 for a complete description of the errors.
Sensor 4 Warnings	------	Integer	Current warning value. Refer to Table 5-23 for a complete description of the warnings.
Sensor 4 Sample Number	0 – 255	Byte	The current sample number.
Sensor 4 Frequency		Float	
Sensor 4 Amplitude		Float	

Table 5-16 Sensors 4,5 error/warning data set

Name	Range	Data Type	Note
Sensor 4 Heater 1 Current Drawn		Float	
Sensor 4 Heater 2 Current Drawn		Float	
Sensor 5 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 5 Errors	------	Integer	Current error value. Refer to Table 5-22 for a complete description of the errors.
Sensor 5 Warnings	------	Integer	Current warning value. Refer to Table 5-23 for a complete description of the warnings.
Sensor 5 Sample Number	0 – 255	Byte	The current sample number.
Sensor 5 Frequency		Float	
Sensor 5 Amplitude		Float	
Sensor 5 Heater 1 Current Drawn		Float	
Sensor 5 Heater 2 Current Drawn		Float	

5.4.2.2.6 5 Sensors' Concentration Data Set

This data set returns a compound set of concentration values for all five of the sensor cards.

Table 5-17 5 sensors' concentration data set

Name	Range	Data Type	Note
Cached Data Set	9	Byte	Numeric value of the data set cached.
Boards Present Indicator	0 – 0x1F	Byte	Bitwise: Bits 0 – 4 set indicate sensor board 1 – 5 present, respectively.
Sensor 1 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 1 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 2 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.

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Table 5-17 5 sensors' concentration data set (continued)

Name	Range	Data Type	Note
Sensor 2 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 3 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 3 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 4 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 4 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.
Sensor 5 SS, LS, MH1/PC, MH2/UZ, AT, CS, ER, RS, BM, WA	Refer to Table 5-18	Integer	Status bits Refer to Table 5-18. SS bit is not relevant in the data set format.
Sensor 5 Concentration	0.0 – 100.0 mole %	Float	The current concentration value.

5.4.3 DeviceNet INFICON Messaging

All information exchanges are formatted and accessed via the Assembly Object (04h, Instances 64h, 96h). Transactions with Composer Elite follow the form of Host setting the Assembly Object data field (CE IN data) following the content below (starting at section 5.4.3) and when the change indicator (Transmit / Receive Message Count field) changes the response content is ready to be read out. Each new command (CE IN data) must update the Transmit / Receive Message Count field to signal the Composer Elite communications process that a new command is pending.

NOTE: The body of the CE IN and CE OUT data block (bytes 2 … n) after the Transmit / Receive Message Count field are identical to messages exchanged over RS-232.

5.5 Message Format

Standard message protocol serves as a structure for the contained command or response information. It also can provide a level of acknowledgment between the host and server and a mechanism for verifying the information content.

5.5.1 Command

This section describes the command format.

See section 5.6, Communication Commands, on page 5-27 for details on specific command IDs.

The message received by Composer Elite contains a data packet preceded by a length and terminated by a checksum.

Composer Elite will always send a response to any command it receives.

5.5.1.1 Command Packet (Host to Composer Elite Message)

<Length><Message><Checksum>

Length . . . . 2 bytes Low / High (not including checksum or length bytes). Numeric value representing the number of characters in the command. In order of transmission, the low byte will precede the high byte. Normally, the number for characters will be less than 9. In this case, the low byte will contain the character count while the high byte will have zero value.

Message . . . . <Command>

Checksum . . . . 1 byte, sum, modulo 256, of all bytes, not including length. Modulo 256 is the numeric value from 0 to 255 representing the modulo 256 remainder of the sum of the values of the ASCII codes that comprise the command.

5.5.2 Response

This section describes the response format that is returned in the data field of the response message. See section 5.6, Communication Commands, on page 5-27 for more details on responses. The message sent by Composer Elite contains a data packet preceded by a length and terminated by a checksum. See section 5.5.2.1 for a detailed description of the received message structure.

If a command generates an error in response, an error code is returned (see section 5.5.2.2) in the Response Message and the SS bit in the status byte (see Table 5-18 on page 5-24) is set to 0. The SS bit is set to 1 indicating successful completion of the received command.

5.5.2.1 Response Packet (Composer Elite to Host Message)

<Length><Command><Command ID><Sensor><Internal Parameter><Status><Message><Checksum>

Length . . . . 2 bytes Low / High (not including checksum or length bytes). Numeric value representing the number of characters in the response. Two byte values, high and low order, are required to represent this number. In order of transmission, the low byte will precede the high byte.

Command . . . . Reports the command sent by the host.

Command ID . . . . Reports the subcommand sent by the host.

Sensor . . . . Reports the sensor number sent by the host.

Internal Parameter . . . . Reports the parameter number sent by the host.

Status. . . . . Received as a hex value. Converted to Bits: **<SS><LS><computer><UZ><AT><CS><ER><RS><BM><WA>**. See Table 5-18.

Message . . . . This field contains the data being sent to the requesting application by Composer Elite. This field is optional and the format of any returned data is determined by the specific command. Refer to section 5.6 for a detailed description of all possible responses.

Checksum . . . . 1 byte, sum, modulo 256, of all bytes, not including length and checksum. Modulo 256 is the numeric value from 0 to 255 representing the modulo 256 remainder of the sum of the values of the ASCII codes that comprise the response.

5.5.2.2 Communication Error Codes

If there was an error detected with the command sent to Composer Elite, the response message will have the MSB of the status byte (SS bit) cleared (see Table 5-18 on page 5-24). The data portion of the message will be one byte long and will be one of the following:

3 (0x03) . . . . Message length is zero*

10 (0x0A) . . . Invalid sensor number

11 (0x0B) . . . Invalid program number

12 (0x0C) . . . Uninstalled sensor number

17 (0x11) . . . Message length incorrect for given command

18 (0x12) . . . Message checksum invalid*

19 (0x13) . . . Sent data out of range

20 (0x14) . . . Unknown command

21 (0x15) . . . Data requested not currently available

22 (0x16) . . . Message timeout. Entire message not received in 3 seconds.*

23 (0x17) . . . Action could not be completed. (e.g., A zero frequency command was sent when the Acoustic Sensor's frequency was not "STEADY")

22 (0x18) . . . File system in use. Try command again later.

* Indicates a hard communication error. When a hard communication error occurs, the response message's header (Command, Subcommand, Sensor, and Program) will be filled in with 0xFF since a valid command packet was not received.

Table 5-18 Status bit

Status Bit	Name	Value	Data Type	Note
SS	Status Signal (Bit 31)	0|1	Bit	0=Error in received message. Data field will contain error code. Refer to section 5.5.2.2, Communication Error Codes, on page 5-23. 1=Message received successfully.
LS	Status Field (Bit 30)	0|1	Bit	0= Short Status Field (8 bits) 1= Long Status Field (16 bit)
PC	Power Cycle (Bit 29)	0|1	Bit	When Sensor Number is 1-5: 0= No change in sensor's setpoint/gas parameters. 1= One of the sensor's setpoint/gas parameters have changed (computer bit flag will be cleared). When Sensor Number is 0: 0= No change in any of the sensor's setpoint/gas parameters. 1= One of the sensor's setpoint/gas parameters have changed (computer bit flag will be cleared).

Table 5-18 Status bit (continued)

Status Bit	Name	Value	Data Type	Note
UZ	Zero Reference (Bit 28)	0|1	Bit	When sensor number is 1-5: 0= Sensor is using Factory Zero. 1= Sensor is using User Zero. When Sensor Number is 0: 0= All the sensors are using the Factory Zero. 1= At least one of the sensors is using the User Zero.
AT	At Temperature (Bit 27)	0|1	Bit	When sensor number is 1-5: 0= Sensor is not at temperature (neither heater is at temperature). 1= Sensor is at temperature (heater 1 within +/-0.002ºC and heater 2 within +/-0.005°C). When Sensor Number is 0: 0= Not all of the online sensors are at temperature. 1= All the online sensors are at temperature.
CS	Concentration Steady (Bit 26)	0|1	Bit	When sensor number is 1-5: 0= Sensor Concentration is currently not steady. 1= Sensor Concentration is currently steady. When Sensor Number is 0: 0= Not all the online sensors currently have steady concentration. 1= All the online sensors currently have a steady concentration.
	Reserved (Bit 25)			
ER	Errors (Bit 24)	0|1	Bit	When sensor number is 1-5: 0= Sensor currently does not have any errors. 1= Sensor currently does have errors. When Sensor Number is 0: 0= None of the sensors currently have errors. 1= At least one of the sensors currently have errors.
RS	Reset (Bit 23)	0|1	Bit	0= There has not been a power cycle/reset. 1= There has been a power cycle since the previous command. When sent sensor to controller: bit indicates sensor card reset. When sent control to external host: bit indicates controller card reset or a box power cycle. (bit cleared after returned).

Table 5-18 Status bit (continued)

Status Bit	Name	Value	Data Type	Note
BM	Boot Monitor (Bit 22)	0|1	Bit	When sensor number is 1-5: 0= Sensor is currently running application code. 1= Sensor is currently running boot monitor code. When Sensor Number is 0: 0= All of the sensors are running application code. 1= At least one of the sensors is currently running boot monitor code.
WA	Warning (Bit 21)	0|1	Bit	When sensor number is 1-5: 0= Sensor currently does not have any warnings. 1= Sensor currently does have warnings. When Sensor Number is 0: 0= None of the sensors currently have warnings. 1= At least one of the sensors currently have warnings.
	Reserved (Bit 20-0)			

5.6 Communication Commands

The following shows a summary of the available commands. The headers/trailers are assumed.

H . . . . Hello. Returns the model and software version number. (See section 5.6.1. and section 5.7.1 on page 5-37.)

Q . . . . Query. Interrogates the programmable parameters and returns the value of parameter requested. (See section 5.6.2 on page 5-28 and section 5.7.2 on page 5-37.)

U . . . . Update. Replaces the particular parameter value with the value sent. (See section 5.6.3 on page 5-29, section 5.7.3 on page 5-38, and section 5.7.4 on page 5-38.)

S . . . . Status. Sends back pertinent information based on the specific request made. (See section 5.6.4 on page 5-30 and section 5.7.5 on page 5-39.)

R . . . . Remote. Perform an action based on the specific command given. Many of these mimic front panel keystrokes. (See section 5.6.5 on page 5-36 and section 5.7.6 on page 5-40.)

5.6.1 Hello Command

Message = H <Command ID> <Sensor> <Internal Parameter>

Command ID = <Byte> 0-1

Sensor = <Byte> 0-5 The control card is represented with a 0.

Internal Parameter = <Byte> 0

Response = <String>|<Byte> See Table 5-19.

Table 5-19 Hello command response

H Command ID	Name	Value	Range (low/high)	Data Type	Note
0	Hello String	Composer Elite ver. xx.xx.xx	8x21	String	The model and version numbers of Composer Elite, 'Composer Elite ver xx.xx.xx' where xx.xx.xx is the version number.
1	Hello Binary	Version Major	0-99	Byte	Major Version Number.
		Version Minor	0-99	Byte	Minor Version Number.
		Version Build	0-99	Byte	Build Version Number.

5.6.2 Query Commands

Message = Q <Command ID><Sensor><Internal Parameter>

Command ID = <Byte> See Command ID in Table 5-20.

Sensor = <Byte>1-5

Internal Parameter = <Byte> 0

Response = <Float> See range column in Table 5-20.

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5.6.3 Update Commands

Message = U <Command ID><Sensor><Internal Parameter><Data>

Command ID = <Byte> See Command ID in Table 5-20.

Sensor = <Byte> 1-5

Internal Parameter = <Byte> 0

Data = <Float> See range column in Table 5-20.

Response = None (header and trailer only)

Table 5-20 Query & Update commands

Q & U Command ID	Name	Range (low/high)	Data Type	Note	Restrictions
2	Carrier Molecular Weight	1.000 - 1000.000 (AMU)	Float	This value represents the molecular weight of the lighter gas.	-
3	Carrier Gamma	1.0000 - 2.0000	Float	This value represents the Carrier's specific heat ratio.	-
4	Precursor Molecular Weight	1.000 - 1000.000 (AMU)	Float	This value represents the molecular weight of the heavier gas.	-
5	Precursor Gamma	1.0000 - 2.0000	Float	This value represents the Precursor's specific heat ratio.	-
6	Allow User Zero	0-1	Integer	Current value of Allow User Zero.	-
7	Reserved For Future Use				
8	Reserved For Future Use				
9	Query Zone 1 Temperature	30.00 - 65.00(ºC)	Float	Current value of the Zone 1 Temperature Setpoint parameter of the Acoustic Sensor's resonant chamber.	-
	Zone 2 Delta	-99.999 - 99.999(ºC)	Float	Current value of the Zone 2 Temperature Delta parameter of the Acoustic Sensor's resonant chamber.	Will reject an update for Heater 2 if the temperature is not within the 30 to 68°C range.
10	Result Averaging Filter Depth	0-100	Integer	Current value of Averaging Filter Depth.	-
20	Sets/Gets Bit Pattern for S0 Command	0 - 0x7FF8 0000	Encode	Each bit represents a piece of data returned. When a bit is set (1) that piece of data is returned in the S0 command response. Refer to Table 5-18 for details of which byte relates to what data. Bit = 0 Data not sent. Bit = 1 Data is sent.	

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5.6.4 Status Commands

Message = S <Command ID>(<Sensor>)(<Temperature Zone>|<Heater ID>)

Command ID = <Byte> See Command ID in Table 5-21.

Sensor = <Byte>1-5. Use 0 for Command S7.

(Temperature Zone) = <Byte> 1-2 Used only with Command S1. 0 if unused.

(Heater ID) = <Byte>1-2 Used only with Command S3. 0 if unused.

Response = <Byte>|<Float>|<Encode>|<Short>| See Data Range & Type columns in Table 5-21.

Table 5-21 Status commands

S Command ID	Name	Parameter	Range (low/high)	Data Type	Note
0	Current Data	Reserved (U20 - Bit 31)			Must always be 0.
		Bit Pattern (U20 - Bit 30)			The value of the 4 Byte word returned.
		Measurement Mode (U20 - Bit 29)	0-6	Encode	0 = Idle 1 = Ready 2 = Search 3 = Track 4 = Quick Track 6 = Baseline
		Concentration (U20 - Bit 28)	(mole%)	Float	The current concentration value. (mole%)
		Temperature 1 (U20 - Bit 27)	0.0 - 71.00(°C) 99.999	Float	The current temperature value of Acoustic Sensor's resonant chamber. 99.999 if cable is disconnected.
		Temperature 2 (U20 - Bit 26)	0.0 - 75.00(°C) 99.999	Float	The current temperature value of Acoustic Sensor's inlet tube. 99.999 if cable is disconnected.
		Errors (U20 - Bit 25)	0 - 0xFFFF FFFF	Encode	Current error value. See Table 5-22 on page 5-32.
		Warning (U20 - Bit 24)	0 - 0xFFFF FFFF	Encode	Current warning value. See Table 5-23 on page 5-34.
		Heater Status 1 (U20 - Bit 23)	0-6	Short	Status of Acoustic Sensor's resonant chamber heater: 0 = Off 1 = Not at Temperature 2 = At Temperature 3 = Failed 4 = Cable Disconnected 5 = Near Temperature 6 = Over Temperature
		Heater Status 2 (U20 - Bit 22)	0-6	Short	Status of Acoustic Sensor's inlet tube heater: 0 = Off 1 = Not at Temperature 2 = At Temperature 3 = Failed 4 = Cable Disconnected 5 = Near Temperature 6 = Over Temperature
		Sample Number (U20 - Bit 21)	0-255	Byte	The current sample number.
		Frequency (U20 - Bit 20)		Float	The current frequency.
		Amplitude (U20 - Bit 19)		Float	The current amplitude.
		Reserved (U20 - Bits 18-0)			Must always be 0.

Table 5-21 Status commands (continued)

S Command ID	Name	Parameter	Range (low/high)	Data Type	Note
1	Current Temperature	Temperature Zone 1|2	30.0 - 65.00(°C) 99.999	Float	Current Zone Temperature 1 for Acoustic Sensor's resonant chamber. (99.999 if cable is disconnected.)
			30.0 - 68.00(°C) 99.999	Float	Current Zone Temperature 2 for Acoustic Sensor's inlet tube. (99.999 if cable is disconnected.)
3	Heater Status	Heater ID 1|2	0-6	Short	Status of Acoustic Sensor's resonant chamber heater (1) and inlet tube heater (2): 0 = Off 1 = Not at Temperature 2 = At Temperature 3 = Failed 4 = Cable Disconnected 5 = Near Temperature 6= Over Temperature
7	Boards Present	Active Sensor Boards. Bits 0-4 indicate sensor board 1-5 present.	0x1F	Byte	0 = board not present. 1 = board present.
8	Keyboard Lock State		0|1	Byte	0 = Locked, 1 =Unlocked.
9	Errors/ Warnings Code	Errors	0 - 0xFFFF	Short	Current error value. See Table 5-22.
		Warnings	0 - 0xFFFF	Short	Current warning value. See Table 5-23.

Table 5-22 System and hardware errors

Error Number	Description	Error Code	Set by CC or SC	Sensor Specific (SS)	Set/Clear Trigger	General Notes/Actions
32	Manual Parameter Reset Required	0x8000 0000	CC		Does not clear	NOTE: Expected to occur because of any errors that occur even though the flash versions are compatible. ACTION(CC): Parameters will lock internally. Operation will be suspended.
31	Parameter Flash HW Failure	0x4000 0000	CC		Does not clear	ACTION(CC): Parameters will lock internally. Operation will be suspended. NOTE: Indicates that the flash is not responding correctly to the read/write requests.
30	Image Flash HW Failure	0x2000 0000	CC		Cleared on read	NOTE: Indicates that the flash is not responding correctly to the read requests.
CC = Controller Card, SC = Sensor Card, [3]SS = Specific Sensor						

Table 5-22 System and hardware errors (continued)

Error Number	Description	Error Code	Set by CC or SC	Sensor Specific (SS)	Set/Clear Trigger	General Notes/Actions
29	DeviceNet HW Failure	0x1000 0000	CC		Self Clear	NOTE: Indicates that the DeviceNet module is self-reporting a hardware failure.
28	Temperature HW Failure	0x0800 0000	CC		Self Clear	NOTE: Indicates that the temperature reading being reported is invalid.
20	Temperature 2 Calculated Out of Range	0x0008 0000	CC		Self Clear	ACTION(CC): Temperature 2 parameter value will be held at the limit.
19	Carrier and Precursor Gases Chosen Are Identical	0x0004 0000	CC	SS	Self Clear	
18	CC Has Lost Communications with SC	0x0002 0000	CC	SS	Self Clear	
17	SC/CC Major Version Mismatch	0x0001 0000	CC	SS	Self Clear	ACTION(CC): Operation will be suspended.
16	Sensor (Cell)/Cable Not detected	0x0000 8000	SC	SS	Self Clear	ACTION(SC): SC will remain in Ready/Idle state until connected. ACTION(CC): CC may reallocate any power management resources assigned to the SC.
15	Heater 1 Temperature - Outside Operating Range	0x0000 4000	SC	SS	Self Clear	ACTION(SC): SC disables Heater ACTION(CC): CC may reallocate any power management resources assigned to the SC. NOTE: Temperature outside operating range.
14	Heater 2 Temperature - Outside Operating Range	0x0000 2000	SC	SS	Self Clear	ACTION(SC): SC disables Heater ACTION(CC): CC may reallocate any power management resources assigned to the SC. NOTE: Temperature outside operating range.
13	Heater 1 Current - Expectations Not Met	0x0000 1000	SC	SS	Self Clear	ACTION(SC): SC disables Heater. ACTION(CC): CC may reallocate any power management resources assigned to the SC. NOTE: Does not meet expectation based on PWM duty.
CC = Controller Card, SC = Sensor Card, [3]SS = Specific Sensor						

Table 5-22 System and hardware errors (continued)

Error Number	Description	Error Code	Set by CC or SC	Sensor Specific (SS)	Set/Clear Trigger	General Notes/Actions
12	Heater 2 Current - Expectations Not Met	0x0000 0800	SC	SS	Self Clear	ACTION(SC): SC shuts off Heater. ACTION(CC): CC may reallocate any power management resources assigned to the SC. NOTE: Does not meet expectation based on PWM duty
11	Heater 1 Setpoint - Bad Parameter	0x0000 0400	SC	SS	Cleared on read	NOTE: Attempt made to set parameter above operating range (>65°C).
10	Heater 2 Setpoint - Bad Parameter	0x0000 0200	SC	SS	Cleared on read	NOTE: Attempt made to set parameter above operating range (>68°C).
CC = Controller Card, SC = Sensor Card, [3]SS = Specific Sensor						

Table 5-23 System and hardware warnings

Warning Number	Description	Warning Code	Set by CC[1] or SC[2]	Sensor Specific (SS[3])	Set/Clear Trigger	General Notes/Actions
32	Composer Elite Temperature Outside Operating Range	0x8000 0000	CC		Self clear	
31	DeviceNet Installed but Not Operating	0x4000 0000	CC		Self clear	NOTE: Indicates that the DeviceNet module was found but DeviceNet system is not currently operating.
30	DeviceNet Failed to Transmit a Response	0x2000 0000	CC		Cleared on read	NOTE: Failed to transfer response from CC to ABIC[4] module.
29	Parameters Reset	0x1000 0000	CC		Cleared on read	NOTE: Could be result of automatic parameter reset due to compatibility error or from a manual reset.
28	CC Firmware Changed	0x0800 0000	CC		Cleared on read	
27	Splash Image Incompatible or Invalid	0x0400 0000	CC		Cleared on read	NOTE: The splash image read is not compatible with the system expectations and thus cannot be displayed.
26	Parameters Upgraded	0x0200 0000	CC		Cleared on read	
[1]CC = Controller Card, [2]SC = Sensor Card, [3]SS = Specific Sensor, [4]ABIC = Anybus Integrated Circuit, [5]R2= Lorentzian Coefficient of Determination						

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Table 5-23 System and hardware warnings (continued)

Warning Number	Description	Warning Code	Set by CC[1] or SC[2]	Sensor Specific (SS[3])	Set/Clear Trigger	General Notes/Actions
21	Gap in Sensor Calulations Detected	0x0010 0000	CC	SS	Cleared on read	NOTE: Latest sample number cached from SC differs by more than 1 from the last sample number cached.
20	SC Reset Detected	0x0008 0000	CC	SS	Cleared on read	
19	All CC/SC Command Retries Have Failed	0x0004 0000	CC	SS	Cleared on read	NOTE: CC has transmitted a command to the SC the maximum number of times without receiving a response. Attempt has been abandoned.
18	Sensor Offline	0x0002 0000	CC	SS	Self Clear	
17	Sensor firmware Changed	0x0001 0000	CC	SS	Cleared on read	
16	Board Temperature Outside Operating Range	0x0000 8000	SC	SS	Cleared on read	NOTE: PCB temp outside normal operating range. Normal Operating Range: 0.0-82.0ºC.
15	No Signal (Cable detected)	0x0000 4000	SC	SS	Self Clear	NOTE: No/very low (below operating threshold) audio signal. Sensor card will continually be in Search mode.
14	Concentration Result Error	0x0000 2000	SC	SS	Self Clear	NOTE: Generally indicates a change in gas flow/mixture. SC will perform new sweep if it persists more than a few seconds.
13	Bad peak Shape	0x0000 1000	SC	SS	Self Clear	NOTE: Indicated by low $R2^5$ / high Std Err.

[1]CC = Controller Card, [2]SC = Sensor Card, [3]SS = Specific Sensor, [4]ABIC = Anybus Integrated Circuit,
[5]R2= Lorentzian Coefficient of Determination

5.6.5 Remote Commands

Message = R <Command ID>(<Sensor>)(<Internal Parameter>)

Command ID = <Byte> See Command ID in Table 5-24.

(Sensor) = <Byte> 1-5 Used with Command R2. 0 if unused.

(Internal Parameter) = <Byte> 0.

Response = None (header and trailer only)

Table 5-24 Remote commands

R Command ID	Name	Note	Restrictions
2	Zero Frequency	User Zero	When steady and at temperature, User Zero enabled.
3	Revert to Factory Zero		-
8	Lock Keyboard	Locks the Composer Elite keyboard.	-
9	Unlock Keyboard	Unlocks the Composer Elite keyboard.	-

5.7 Composer Elite Communications Examples

Commands and responses are all done using hexadecimal representation.

5.7.1 Hello Command, ASCII Name and Version

Command Format: H <Command ID> <Sensor 0-5> <Internal Parameter>

Command (H 0 0 0): 04,00,48,00,00,00,48

04,00 = Length
48,00,00,00 = Command
48 = Checksum

Response: 22,00,48,00,00,00,C1,80,43,6F,6D,70,6F,73,65,72,20,45,6C,69,74,65,20,76,65,72,20,30,31,2E,30,30,2E,36,33,00,F7

22,00 = Length
48,00,00,00 = Command
C1,80 = Status bytes
43,6F,6D,70,6F,73,65,72,20,45,6C,69,74,65,20,76,65,72,20,30,31,2E,30,30,2E,36,33,00 = Message, String
- Message translates to "Composer Elite ver 01.00.63 (null terminated string)
F7 = Checksum

5.7.2 Query Command, Carrier Molecular Weight

Command Format: Q <Command ID> <Sensor 1-5> <Internal Parameter>

Command (Q 2 1 0): 04,00,51,02,01,00,54

04,00 = Length
51,02,01,00 = Command sent
54 = Checksum

Response: 0A,00,51,02,01,01,C1,00,7B,14,E0,41,C6

0A,00 = Length
51,02,01,01 = Command
C1,00 = Status bytes
7B,14,E0,41 = Float value (High to low)
- Change to low to high (41,E0,14,7B) and convert to decimal = 28.010
C6 = Checksum

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5.7.3 Update Command, Carrier Molecular Weight

Command Format: U <Command ID> <Sensor 1-5><Internal Parameter><Data>

Command (U 2 1 0 128.53): 08,00,55,02,01,00,AE,87,00,43,D0
08,00 = Length
55,02,01,00 = Command
AE,87,00,43 = Float value (128.53)
- Value as converted from Decimal to hex is actually 43,00,87,AE but, hex value must be sent High(MSB) to Low(LSB) therefore, it is sent as AE,87,00,43
D0 = Checksum

Response: 06,00,55,02,01,00,E1,00,39
06,00 = Length
55,02,01,00 = Command
E1,00 = Status Bytes
39 = Checksum

No message returned. Had the command not been successful an error code would have changed the status bit of the status byte.

5.7.4 Update Command, Set Bit Pattern for S0 Command

To set the bit pattern for the S0 Command,use the S0 command table shown in Table 5-21 on page 5-31 to determine which parameters should be shown and which should not be shown when the S0 command is used.

For example, to exclude the parameters: Errors (Bit 25), Warnings (Bit 24), Heater Status 1(Bit 23), Heater Status 2 (Bit 22), and Sample Number (Bit 21) from being shown in the response to an S0 command, use the following bit pattern:

Figure 5-2 S0 Example Bit Pattern

31							24	23							16	15							8	7							0
0	1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Where the 31 label represents the Reserved (U20- Bit 31) and the 0 label represents the 0 bit of the parameter Reserved (U20- Bits 18-0).

When translated into Hex, the binary pattern above becomes 7C,18,00,00.

To send this hex value representing the desired bit pattern for the S0 command, the most Significant Byte (MSB) will have to be sent first as this is part of the required protocol for communications with the Composer Elite. Therefore, the Hex value becomes: 00,00,18,7C.

This value can now be plugged into the command format.

Command Format: U <Command ID> <Sensor 1-5> <Internal Parameter><Bit Pattern>

Command (U 20 1 0 bit pattern): 08,00,55,14,01,00,00,00,18,7C,FE
08,00 = Length
55,14,01,00 = Command
00,00,18,7C = hex representation of Bit Pattern (MSB Leading)
FE = Checksum

Response: 06,00,55,14,01,00,FC,00,66
06,00 = Length
55,14,01,00 = Command
FC,00 = Status Bytes
66 = Checksum
No message returned. Had the command not been successful an error code would have changed the status bit of the status byte to 0.

5.7.5 Status Command, Current Data

Command Format: S <Command ID> <Sensor 1-5> <Internal Parameter>

Command (S 0 1 0): 04,00,53,00,01,00,54
04,00 = Length
53,00,01,00 = Command
54 = Checksum

Response:
22,00,53,00,01,00,DC,00,00,00,18,7C,03,00,00,00,2E,FA,58,BA,4A,00,20,42,E7,FF,2B,42,20,13,7F,45, D7,7B,DD,3F,65
22,00 = Length
53,00,01,00 = Command sent
DC,00 = Status Bytes
00,00,18,7C = S0 Bit Pattern (high to low)
03,00,00,00 = Measurement Mode
2E,FA,58,BA = Concentration
4A,00,20,42 = Temperature 1
BA,4A,00,20 = Temperature 2
20,13,7F,45= Frequency
D7,7B,DD,3F = Amplitude
65 = Checksum

5.7.6 Remote Command, Zero Frequency

Command Format: R <Command ID> <Sensor 1-5><Internal Parameter>

Command (R 2 1 0): 04,00,52,02,01,00,55
04,00 = Length
52,02,01,00 = Command
55 = Checksum

Response: 06,00,52,02,01,00,CC,00,21
06,00 = Length
52,02,01,00 = Command
CC,00 = Status Bytes
21= Checksum

No message returned. Had the command not been successful an error code would have changed the status bit of the status byte.

Chapter 6
Composer Elite Multi-Sensor Software

6.1 Introduction

Composer Elite Multi-Sensor Software interfaces Composer Elite with a computer for monitoring and storing data using a standard RS-232C COM port or DeviceNet.

Composer Elite Multi-Sensor Software allows for the simultaneous measurement, graphing and datalogging of up to five sensors. Five sensor tabs, graphing five key variables per sensor, are displayed on the main screen: **Frequency**, **Temperature**, **Concentration**, **Amplitude** and **PWM**. See Figure 6-2 on page 6-4.

If Composer Elite encounters a communications error, it is reported on the bottom of the main screen. See section 6.3.13, Composer Elite Multi-Sensor Software Warnings and Errors, on page 6-17.

6.2 Hardware Requirements

6.2.1 Computer Requirements

Refer to section 1.5.6, Computer Requirements for Composer Elite Multi-Sensor Software, on page 1-13.

6.2.2 RS-232 Requirements

Use a shielded, straight-through cable for RS-232 communications (refer to Table 5-1 on page 5-2 for cable pin connections). If the computer does not have an available RS-232 port, use a USB-Serial Adapter and a straight-through cable.

For information on connecting the RS-232 cable to the Sensor Control Unit, refer to section section 2.2.3, Installing Interconnect, Power Supply, and Communications Cables, on page 2-11.

6.2.3 DeviceNet Requirements

Refer to section 1.5.7, DeviceNet Requirements for Composer Elite Multi-Sensor Software, on page 1-13.

For information on connecting the DeviceNet cable to the Sensor Control Unit, refer to section 2.2.3, Installing Interconnect, Power Supply, and Communications Cables, on page 2-11.

6.2.4 Software Installation

To install Composer Elite Multi-Sensor Software:

1. Insert the 074-5028-G1 Composer Elite Operating Manual CD into the computer drive.
2. Open Windows Explorer and open the drive containing the CD.
3. Open the software folder and double-click the **setup.exe** file to begin installation of the Composer Elite MultiSensor Software.
4. If a Windows security warning appears, select the option to install the software.
5. When software installation is complete, the **Composer Elite Multi Sensor Display** window is displayed (see Figure 6-1 on page 6-3).

NOTE: The installation will look to see if *Microsoft .Net Framework 4 Client Profile* is installed on the computer. If it is not, the installation will attempt to download it from the Microsoft website.

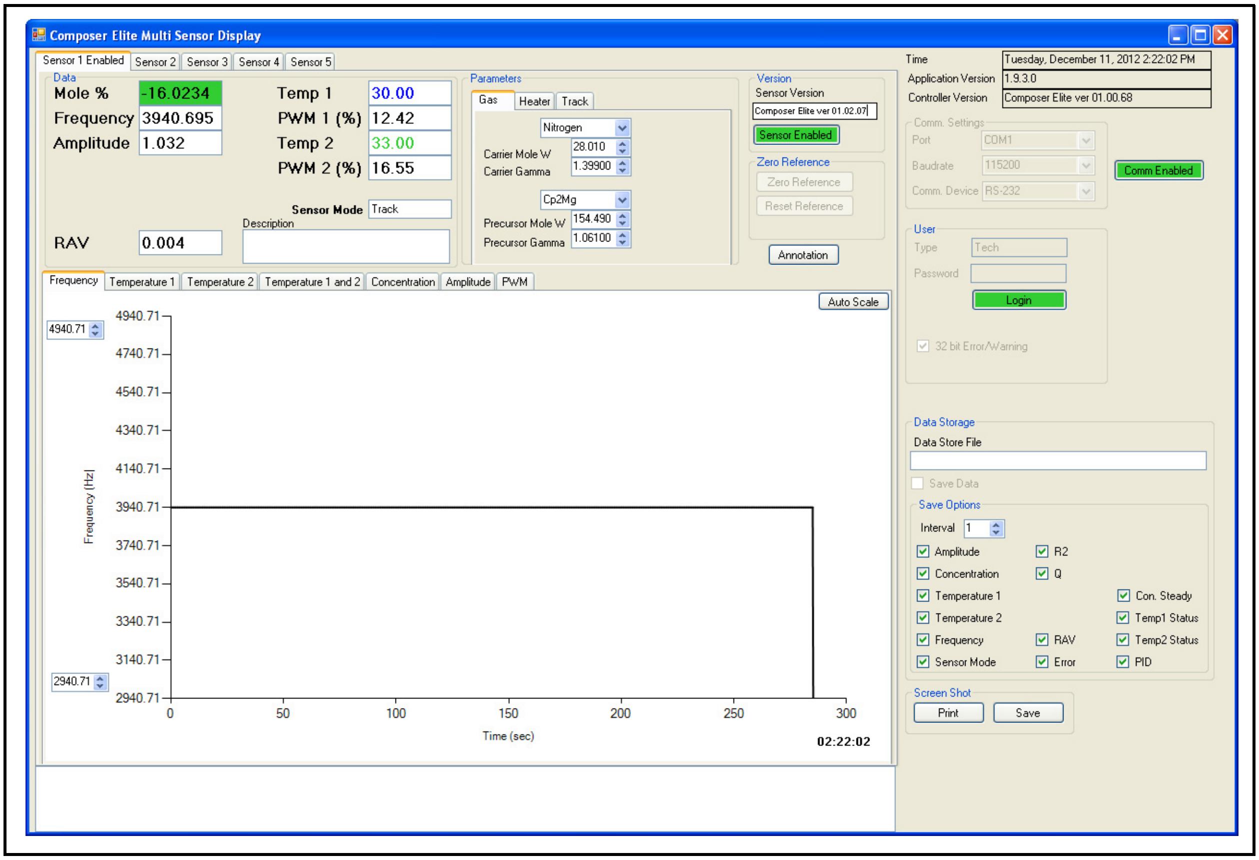
If the computer is not connected to the internet, *Microsoft .Net Framework 4 Client Profile* must be downloaded to an internet-connected computer, and then be transferred to the computer running the Composer Elite MultiSensor Software.

6.3 Operation

If Composer Elite MultiSensor Software is not already open, click Windows **Start** >> **All Programs >> INFICON >> Composer Elite MultiSensor**. The **Composer Elite Multi Sensor Display** window will display. See Figure 6-1.

NOTE: The following sections of this manual should be followed in the order they are presented for initial software setup.

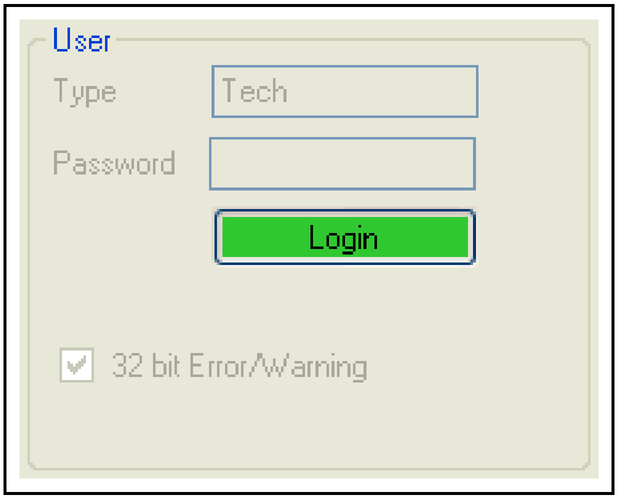
Figure 6-1 Composer Elite multi sensor display



6.3.1 User Login

Composer Elite Multi Sensor Software is locked until a user name and password are entered in the **User** window (see Figure 6-2.) Type the word **Tech** (case sensitive) into the **Type** and **Password** boxes, then click **Login** to unlock the software.

Figure 6-2 User login



6.3.2 Comm Settings

Before Composer Elite Multi-Sensor Software can read data from the Composer Elite System, RS-232 or DeviceNet connection must be established. This is done on the **Comm Settings** window found at the top right of the **Composer Elite Multi Sensor Display** window.

For RS-232 communications:

1. Set the port to the communication port number used by the computer. This communication could be direct RS-232 or via a USB to RS-232 adapter. If using an adapter, make sure the adapter driver is loaded and the device works properly using Hyper Terminal or similar communications application.
2. The **Baud Rate** is fixed at **115,200** baud.
3. Set **Comm Device** to **RS-232**.
4. Press **Comm Disabled** to enable communications. Once communication is established **Comm Enabled** will be displayed and all Comm setting options will be displayed in **grey**. See Figure 6-3.

   NOTE: Comm status is shown by button color, which changes from **Comm Enabled** (green) to **Comm Disabled** (red) depending on comm status.

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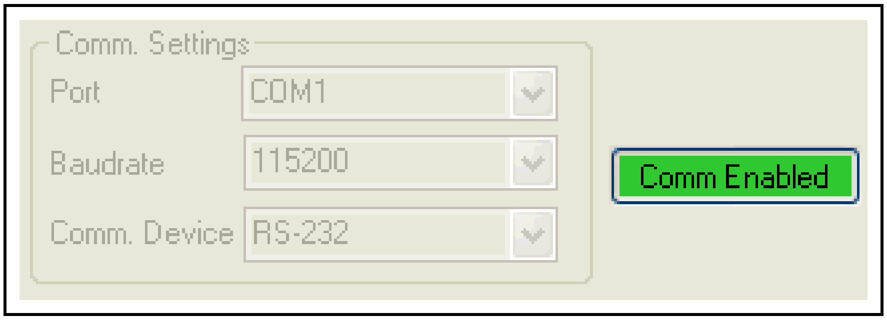
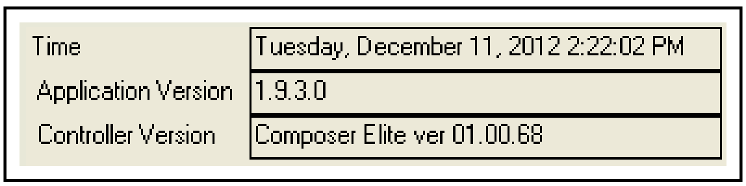
Figure 6-3 Comm Settings window



5 **Application Version** displays the Composer Elite Multi-Sensor Software version. **Controller Version** displays the Sensor Control Unit firmware version. See Figure 6-4.

Figure 6-4 Version information



NOTE: If RS-232 communication is not working properly, make sure the correct communications port is selected.

For DeviceNet communications:

1 Select DeviceNet Beckhoff for the comm device. The port and baud rate fields will be displayed in **grey**.

2 Select **Comm Disabled** to enable communications. Once communication is established, comm settings will turn **grey** and **Comm Disabled** will read **Comm Enabled.**

6.3.3 Data Storage

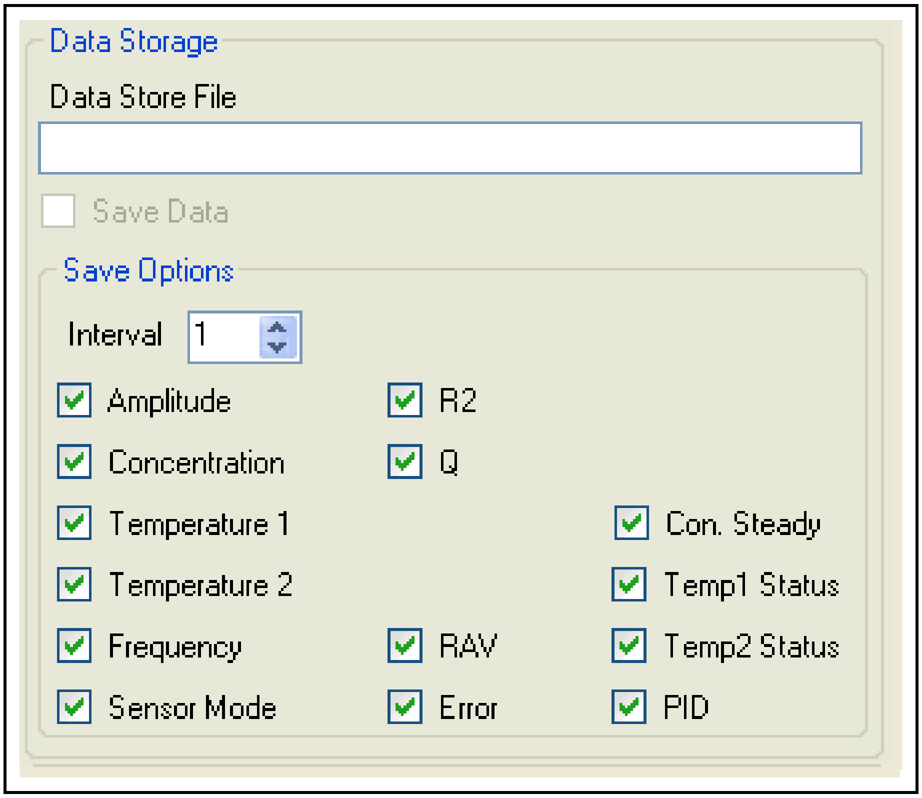
Composer Elite Multi-Sensor Software can log data while the data is being displayed. Select the drive and directory, and enter a filename. The complete path is displayed on the right side of the main screen as shown in Figure 6-5.

When a file path and name are entered into the **Data Store File** field, the current date and time are automatically appended to the end of the user filename.

Selecting **Save Data** creates the new datalog file in the specified location and begins the logging of data. Datalogging will continue until **Save Data** is cleared. The datalog file type is **.csv**.

NOTE: Copy the datalog file to an alternate location before opening it. Opening the datalog file while datalogging is in progress could corrupt the data and cause confusion in the analysis.

Figure 6-5 Data storage



In the **Save Options** pane, the **Interval** number allows you to skip data points and only save data based on the entered **Interval** number. Acceptable **Interval** values are **1 - 99**. Composer Elite takes 1 measurement per second, so if the **Interval** is set to **1** (default value), every measurement is recorded to the log file. Setting **Interval** to **2** would log data every 2 seconds, **3** for every 3 seconds, etc. This is particularly useful when logging data over a long period of time.

The check boxes in the **Save Options** pane select the data of interest to be saved in the datalog. By default, all data is selected.

CAUTION

If the drive runs out of space, datalogging will discontinue and no additional data will be stored.

6.3.4 Diagnostic Files

Composer Elite Multi Sensor Software automatically creates diagnostic files which monitor instrument performance. These files can be very valuable in identifying and troubleshooting any potential problems. There are two file types and as many as six files are saved to the root of the **My Documents** folder. All files older than seven days are automatically deleted. The following file types and contents are created:

File Type 1

One file is created, named **ComposerEliteMultiSensorLog-Cmds_YYYY_MM_DD.CSV**, where **YYYY**, **MM**, and **DD** represent the year, month, and day the file was created.

The file contents are the **Day**, **Date**, and **Time**, followed by **Command** and **Response** for each remote communication with the Composer Elite. Data is stored in Hexadecimal format with check sum fields omitted.

File Type 2

Depending on how many sensors are attached and being monitored, one to five files are created, named **ComposerEliteMultiSensorLog-SX_YYYY_MM_DD.CSV**, where **YYYY**, **MM**, and **DD** represent the year, month, and day the file was created. **SX** represents **Sensor X**, with **X** ranging from **1** to **5**.

The following data is stored in the file, with each line delimited by a comma:

Day Date Time

(OnLine /OffLine)

sample Number

sensor number

Frequency

Amplitude

Current Temperature 1

Current Temperature 2

Concentration

Temperature 1

Temperature 2

Q

R2

Standard Error

Current RAV

Heater 1 Pwm

Heater 2 Pwm

Sensor Mode

Drive

Gain

Depth

Concentration state (1 or 0)

Heater 1 Status

Heater 2 Status

11 point data - Amplitude 1

11 point data - Amplitude 2

11 point data - Amplitude 3

11 point data - Amplitude 4

11 point data - Amplitude 5

11 point data - Amplitude 6

11 point data - Amplitude 7

11 point data - Amplitude 8

11 point data - Amplitude 9

11 point data - Amplitude 10

11 point data - Amplitude 11

11 point data - Frequency 1

11 point data - Frequency 2

11 point data - Frequency 3

11 point data - Frequency 4

11 point data - Frequency 5

11 point data - Frequency 6

11 point data - Frequency 7

11 point data - Frequency 8

11 point data - Frequency 9

11 point data - Frequency 10

11 point data - Frequency 11

PWM Max 1

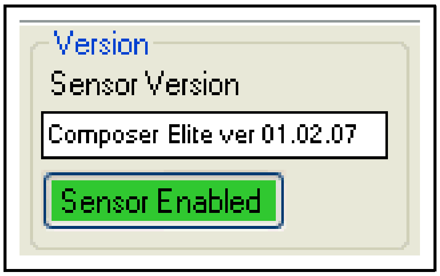
PWM Max 2

PWM Avail

6.3.5 Sensor Version

Once a sensor is communicating with Composer Elite Multi-Sensor Software, **Sensor Disabled** (on the appropriate sensor tab) can be pressed. **Sensor Enabled** is displayed, indicating everything is functioning properly. The sensor firmware version will also be displayed. See Figure 6-6.

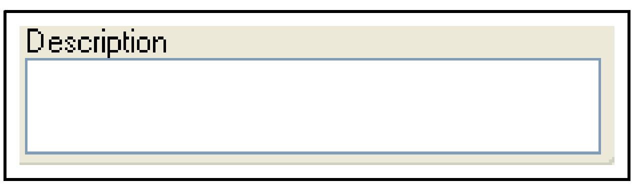
Figure 6-6 Sensor firmware version



6.3.6 Description

The datalog file contains a header that has information about the process, including date and the time. An optional 70 character header may be typed into the **Description** text box (see Figure 6-7). This description will be written to the file when the file is initially created. The sensor must be enabled in order to access this field.

Figure 6-7 Description text box



6.3.7 Parameters

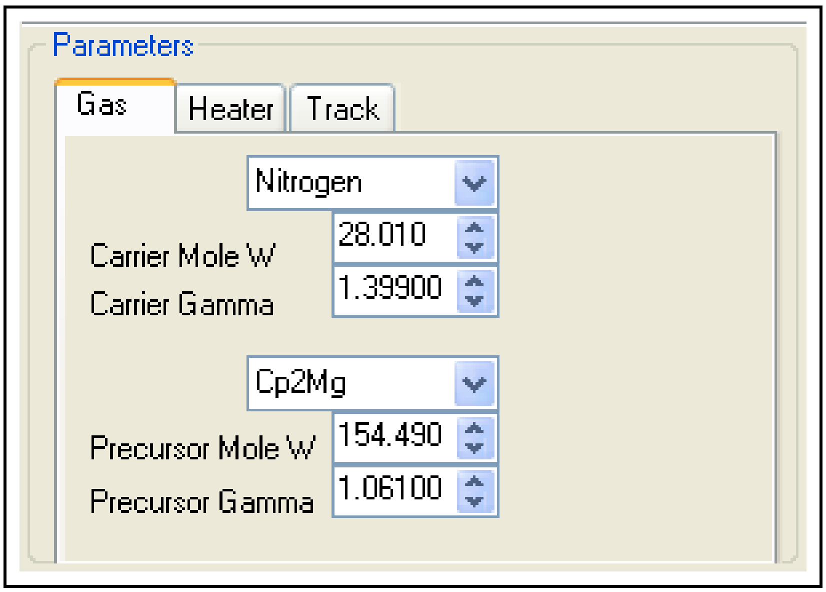
Composer Elite Multi-Sensor Software includes library of the most widely used carrier and precursor gases (see Material Table on page B-1.) Please contact INFICON if you are using gases other than those shown in the Material Table.

Once a parameter is changed, exiting the field will update the parameter in Composer Elite. Changes made at the Composer Elite front panel will not be updated until the sensor is **Sensor Disabled** then **Sensor Enabled**. The current values displayed represent the values in Composer Elite when the sensor was enabled in the software program.

6.3.7.1 Gas

On the **Parameters** window **Gas** tab, select the appropriate Carrier and Precursor gases (see Figure 6-8).

Figure 6-8 Parameter gas tab



Carrier/Precursor Name. . . . . Select precursor gas from the gas properties library list.

Carrier/Precursor Mole Weight . . . Displays the molecular weight of the material. List values range from 1.000 to 1000.000.

Carrier/Precursor Gamma . . . . Displays the material's specific heat ratio. List values range from 1.0000 to 2.0000.

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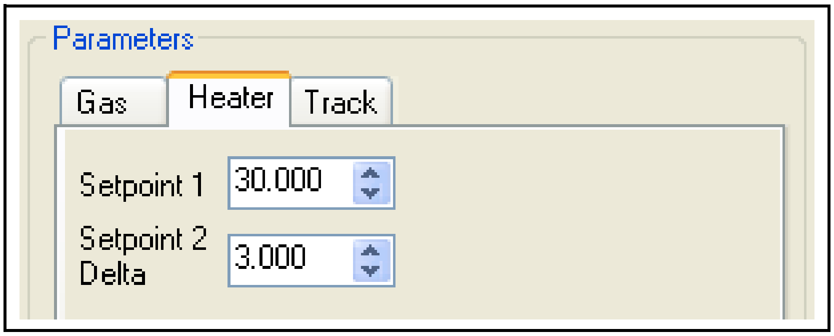
6.3.7.2 Heater

The **Heater** tab (see Figure 6-9) provides lists for changing temperature setpoints for the Acoustic Sensor's resonant chamber and inlet tube.

Figure 6-9 Parameter heater tab



Setpoint 1 . . . . Operating temperature of the Acoustic Sensor's resonant chamber. Values between 30.0 to 65.0°C are supported.

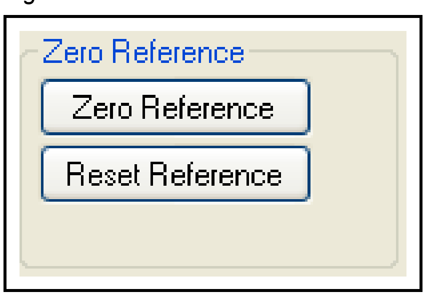
Setpoint 2 Delta . . . . The desired operating temperature for the Acoustic Sensor's inlet tube as a delta from the setpoint 1 temperature. Values between -10 to +10°C are supported. The change to Setpoint 2 will still be limited to the range 30 to 68°C.

6.3.8 Zero Reference

For absolute accuracy, it is recommended that the Reference Zero frequency be established with pure carrier gas before running a process. Calibration obtains the exact frequency and determines Reference Zero. Refer to section 3.2, Calibration, on page 3-2. **Zero Reference** should only be pressed during calibration, as it may cause offset errors in the concentration calculation.

Reset Reference reinstates the Factory Zero calibration value.

Figure 6-10 Zero reference



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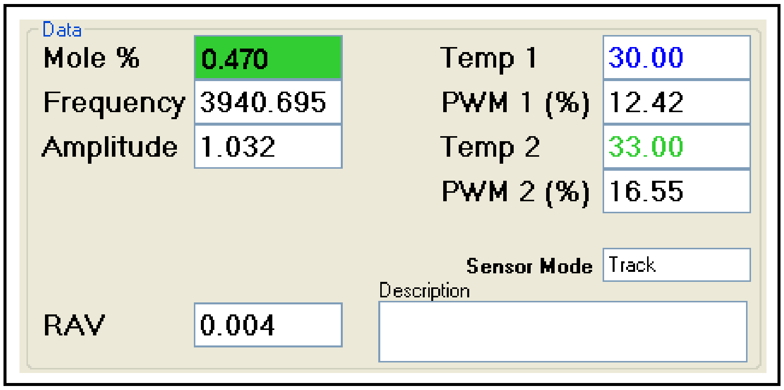
6.3.9 Data

This pane displays the live reading of the given parameters (see Figure 6-11).

Figure 6-11 Data



Mole % . . . . Actual concentration of the precursor. The background of this field is green when in STEADY.

Frequency . . . . Resonance frequency of gas in the cell.

Amplitude . . . . Amplitude of the frequency used to calculate concentration.

Sensor Mode . . . . Current status of the sensor.

PWM 1 & 2 . . . . Power output applied to the Acoustic Sensor's resonant chamber and inlet tube heaters.

Temp 1 . . . . Current temperature of the Acoustic Sensor's resonant chamber. Text in this field will be green when the temperature is at the desired setpoint, blue when it is near the setpoint and red when it is over the temperature setpoint.

Temp 2 . . . . Current temperature of the Acoustic Sensor's inlet tube. Text in this field will be green when the temperature is at the desired setpoint, blue when it is near the setpoint and red when it is over the temperature setpoint.

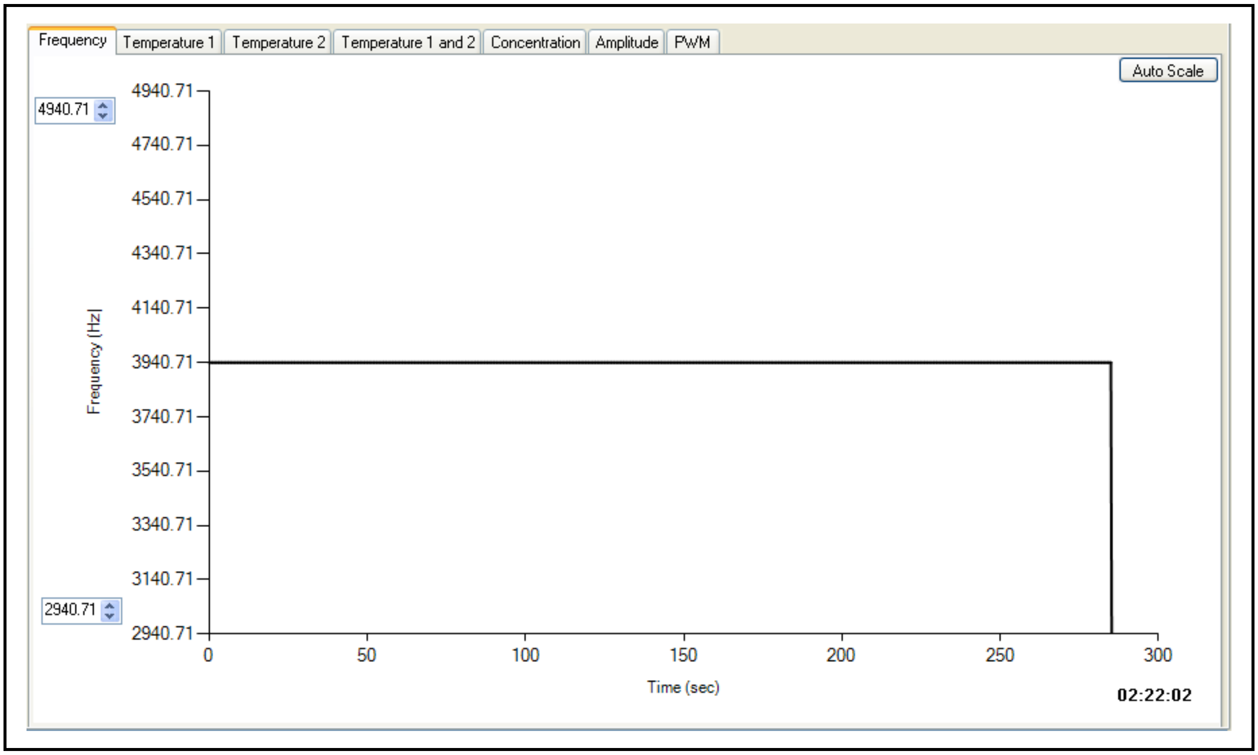
Color of temperature value indicates temperature control status:

- **Black** . . . . Off
- **Orange** . . . . Not at temperature
- **Blue** . . . . Near temperature
- **Green** . . . . At temperature
- **Red** . . . . Over temperature or other fault condition

6.3.10 Graph

Tabs display the data of **Frequency**, **Temperature**, **Concentration**, **Amplitude**, and **PWM**. Charts are presented with most recent data on the left, which moves right over time as newer data is added. Presented ranges can be manually adjusted using the upper and lower bounds immediately to the left of the y axis. See Figure 6-12.

Figure 6-12 Graph display



Frequency . . . . Resonant frequency of the cell. The scale may be changed using the numeric data lists on the left of the graph. **Auto Scale**, at the top right of the graph, can be used to center the data to the displayed scaling.

Temperature 1 . . . . Temperature of the Acoustic Sensor's resonant chamber. The scale may be changed using the numeric data lists on the left of the graph. **Auto Scale**, at the top right of the graph, can be used to center the data to the displayed scaling.

Temperature 2 . . . . Temperature of the Acoustic Sensor's inlet tube. The scale may be changed using the numeric data lists on the left of the graph. **Auto Scale**, at the top right of the graph, will center the data to the appropriate range.

Temperature 1 & 2 . . . . Comparison of the temperatures of the resonant chamber and the inlet tube. The temperature and trend graph will show Temperature 1 in black and Temperature 2 in grey.

Concentration. . . . . Mole % as seen in the upper left corner of the display. The scale may be changed using the lists on the left of the graph. **Auto Scale**, at the top right of the graph, can be used to center the data to the displayed scaling.

Amplitude . . . . Amplitude of the peak frequency used to calculate concentration. The scale may be changed using the lists on the left of the graph. **Auto Scale**, at the top right of the graph, can be used to center the data to the displayed scaling.

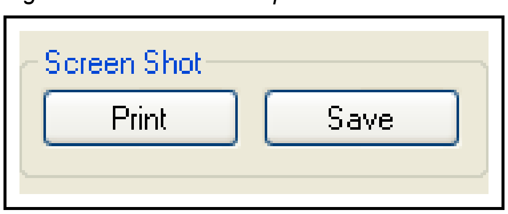
PWM . . . . Power applied to the Acoustic Sensor's resonant chamber and inlet tube heaters (diagnostic purposes only).

6.3.11 Screen Shot

See Figure 6-13.

- **Print** will print a copy of the current software display on the printer assigned to the computer.
- **Save** will save the screen shot as a .png file to a user-defined name and selectable location on the computer.

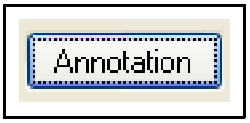
Figure 6-13 Screen shot print and save



6.3.12 Annotation

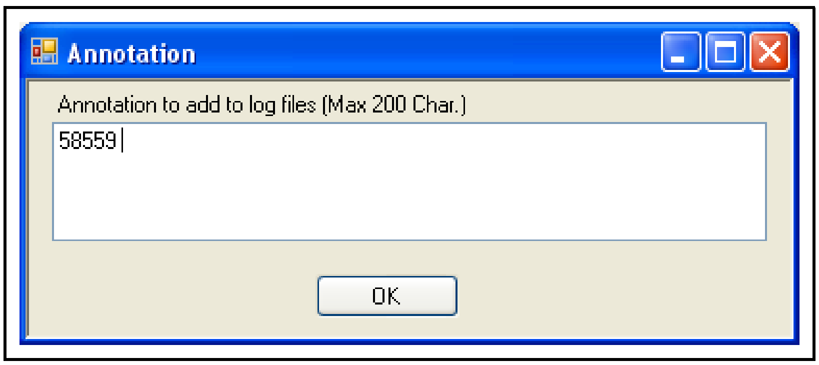
While datalogging, click **Annotation** to add an annotation to the stored data file. See Figure 6-14.

Figure 6-14 Annotation button



The **Annotation** window is displayed, see Figure 6-15. Type a line of text, up to 200 characters long, as an annotation to a particular data point during the process. Click **OK**. The annotation will be saved to a line of data in the datalog file. The **Save Data** check box must be selected to use this feature. By default, seconds after midnight are shown in the text box.

Figure 6-15 Annotation window

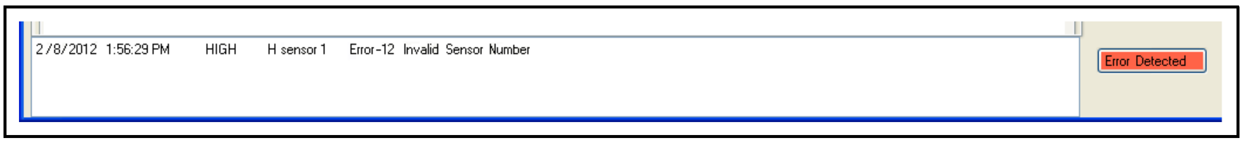


6.3.13 Composer Elite Multi-Sensor Software Warnings and Errors

The warnings and errors log (see Figure 6-16) displays a list of faults, either when a fault occurs or when a fault is removed. Click **Error Detected** to clear the display. The faults are communications errors (refer to section 5.7, Composer Elite Communications Examples, on page 5-37).

Warnings are temporary conditions, which are expected to be self-correcting. Non-fatal errors are recoverable when the fault disappears and require no intervention. In the case of a fatal error, which indicates a hardware problem, Composer Elite must be rebooted (power off, then power on).

Figure 6-16 Warning and errors log



6.3.13.1 Error Messages

Action could not be completed

Comm Error - Access denied, port may already be opened)

Comm Error - Argument passed is null

Comm Error - Argument passed is out of range

Comm Error - Checksum error on received data message

Comm Error - Invalid offset into buffer

Comm Error - The specified port is not open

Comm Error - Transmit / Receive Command error

Comm Error - Unknown Exception

Comm. Error - Communication Timeout

Comm. Error - Port failure

Data requested not currently available

Invalid Checksum

Invalid Command - Unknown Error Value

Invalid Data

Invalid Data Returned

Invalid message length for command

Invalid Program Number

Invalid Sensor Number

Message Timeout

Received message length is zero

Chapter 7 Maintenance

7.1 Scheduled Maintenance

Composer Elite System components do not have wear or anticipated failure characteristics. Therefore, no scheduled maintenance on any components in the Composer Elite System is required.

7.2 Leak Test Procedures

WARNING

Many of the gases used for film growth are toxic at very low exposure levels.

Although the Acoustic Sensor was thoroughly leak tested at the factory, periodic leak testing of the Acoustic Sensor is recommended for safety.

The Composer Elite Acoustic Sensor is constructed in a manner which provides both primary and secondary containment of process gases. Perform the leak test procedures in section 7.2 to verify the leak integrity of the Acoustic Sensor.

7.2.1 Leak Testing the Primary (Resonant) Chamber

The following procedure checks for leaks of the diaphragm and diaphragm seals of the Composer Elite Acoustic Sensor.

WARNING

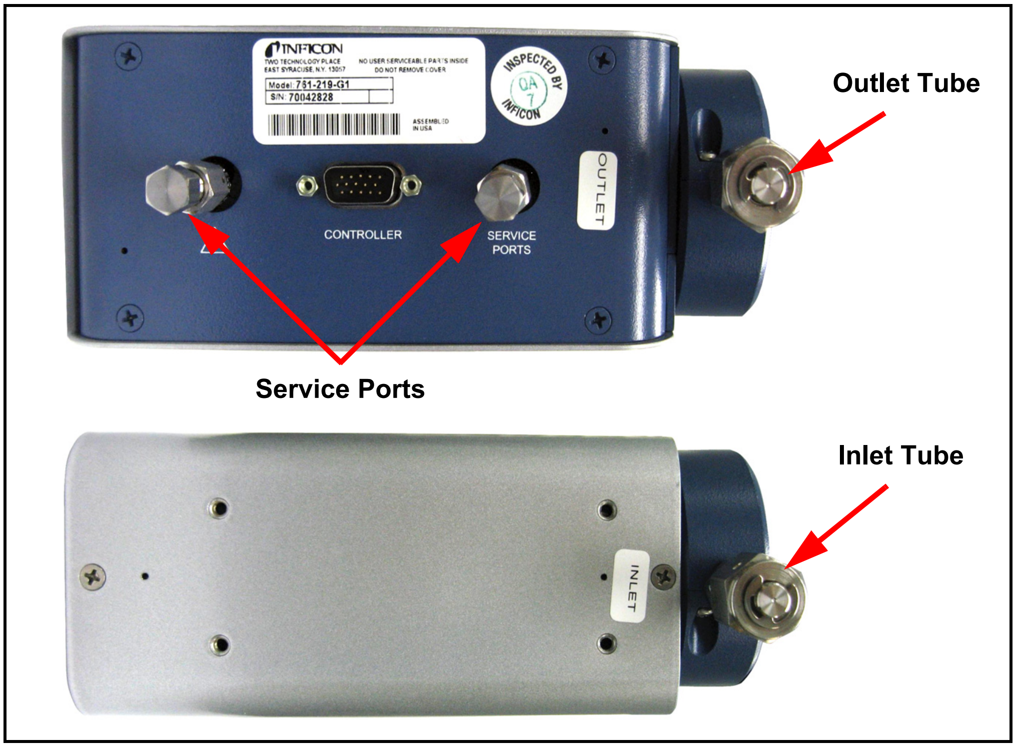
If the Acoustic Sensor has been exposed to toxic, pyrophoric, or otherwise dangerous chemicals, make certain the Acoustic Sensor has been thoroughly purged of these chemicals before performing this leak test.

CAUTION

Do not begin this test until the Acoustic Sensor's temperature drops below 30°C.

1 Remove the plugs from the two VCR-2 service ports (see Figure 7-1). When removing the plugs, simultaneously use two wrenches to avoid stress and damage to the service ports.

Figure 7-1 Acoustic sensor - inlet/outlet tubes and service ports



2 Remove the cap from the VCR-4 fitting on the Acoustic Sensor's inlet tube or outlet tube (refer to Figure 7-1). When removing the cap, simultaneously use two wrenches to avoid stress and damage to the welds and tubing.

NOTE: Do not remove the sealed cap from the other (inlet or outlet) tube.

or

2a Disconnect the Acoustic Sensor's inlet tube and outlet tube VCR-4 fittings (refer to Figure 7-1) from the process tubing, When removing the tubes, simultaneously use two wrenches to avoid stress and damage to the welds and tubing.

3 Connect a helium leak detector to an open inlet or outlet tube. If not already sealed, use a VCR-4 gasket and cap to seal the inlet tube or outlet tube not connected to the leak detector. When connecting the helium leak detector, simultaneously use two wrenches to avoid stress and damage to the welds and tubing. (Swagelok recommends tightening gaskets to 1/8 turn past finger-tight for stainless steel gaskets.)

4 Evacuate the Acoustic Sensor following the leak detector manufacturer's recommendations.

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5 Inject small amounts of helium into each of the two service ports. Verify the leak rate does not exceed 1x10^{-9} cm^3/s.

NOTE: Contact INFICON if the leak rate exceeds 1x10^{-9} cm^3/s.

6 Spray helium around the welded connections of the VCR-4 fittings to the inlet tube and outlet tube. Verify the leak rate does not exceed 1x10^{-9} cm^3/s.

7 Proceed to section 7.2.2 to verify the Secondary Containment Chambers leak integrity.

or

7a If not leak testing the Secondary Containment Chambers, install VCR-2 Ag-plated stainless steel gaskets (PN 059-0640) and the VCR-2 plugs in the service ports. (Swagelok recommends tightening gaskets to 1/8 turn past finger-tight for stainless steel gaskets.)

WARNING

The service ports must be sealed for secondary containment to function in the event of a diaphragm leak.

7.2.2 Leak Testing the Secondary Containment Chambers

Secondary Containment Chambers prevent process gases from escaping the Acoustic Sensor if a diaphragm ruptures or a diaphragm seal fails.

This leak test checks for Secondary Containment Chamber leaks to atmosphere, and for leaks where the tubing is welded to the Acoustic Sensor body.

This leak test may be performed with the Acoustic Sensor connected to the process tubing.

WARNING

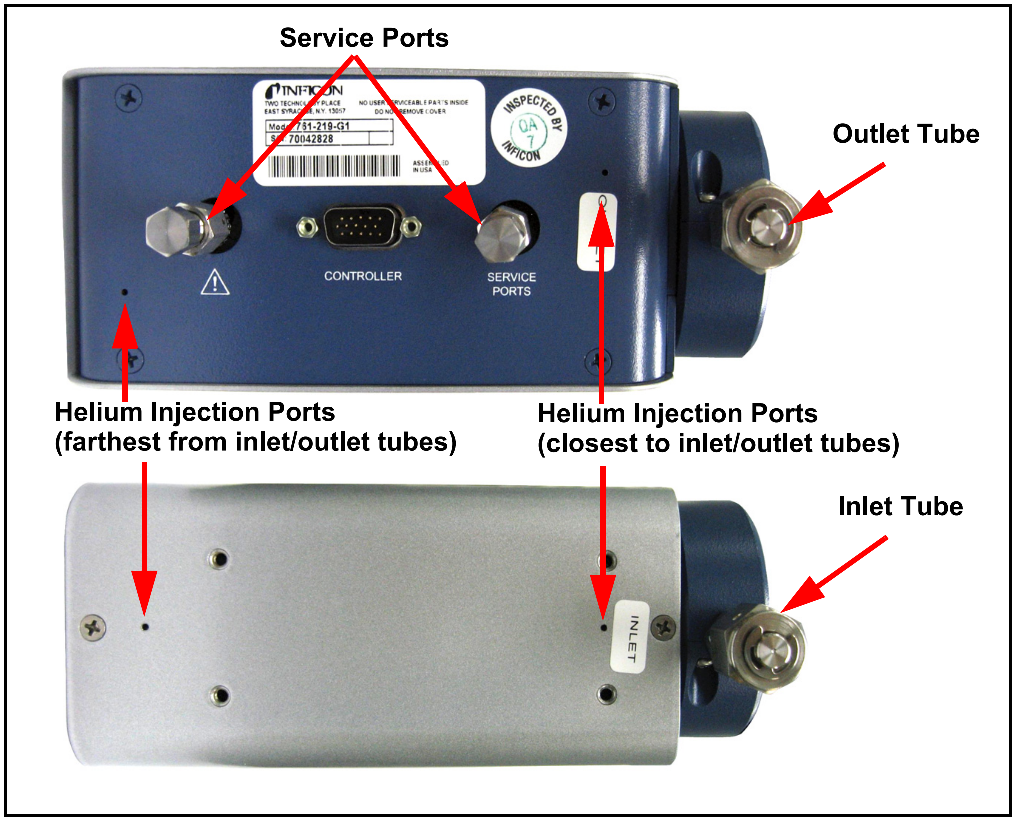
If the process tubing or Acoustic Sensor have been exposed to toxic, pyrophoric, or otherwise dangerous chemicals, thoroughly purge these chemicals before performing this leak test.

CAUTION

Do not begin this test until the Acoustic Sensor's temperature drops below 30°C.

1 If not already removed, remove the plugs from the Acoustic Sensor's two VCR-2 service ports (see Figure 7-2). When removing the plugs, simultaneously use two wrenches to avoid stress and damage to the service ports.

Figure 7-2 Acoustic sensor - inlet/outlet tubes, service ports, and helium injection ports



2 Connect a helium leak detector to either of the two service ports.

3 Evacuate the Secondary Containment Chamber (beneath the service port) by following the leak detector manufacturer's recommendations.

4 Connect the helium injection needle (included in the ship kit) to a helium source. Immerse the needle in liquid and adjust the helium flow for a constant bubble rate of at least two bubbles per second.

5 Locate the two helium injection ports farthest from the Acoustic Sensor inlet and outlet tubes (refer to Figure 7-2). Insert the entire length of the needle into the more easily accessible of the two helium injection ports.

6 Allow the helium to flow into the Acoustic Sensor for at least one minute. If there is a large leak, the leak rate will quickly exceed 1x10^{-9} cm^3/s. For smaller leaks, a gradual pressure increase will be visible. In this case, keep the needle in place for three minutes. The leak rate should not exceed 1x10^{-9} cm^3/s.

NOTE: Contact INFICON if the leak rate exceeds 1x10^{-9} cm^3/s.

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7 Attach the leak detector to the other service port.

8 Evacuate the Secondary Containment Chamber (beneath the service port) by following the leak detector manufacturer's recommendations.

9 Locate the two helium injection ports closest to the Acoustic Sensor inlet and outlet tubes (refer to Figure 7-2). Insert the entire length of the needle into the more easily accessible of the two helium injection ports.

10 Allow the helium to flow into the Acoustic Sensor for at least one minute. If there is a large leak, the leak rate will quickly exceed 1x10-9 cm^3/s. For smaller leaks, a gradual pressure increase will be visible. In this case, keep the needle in place for three minutes. The leak rate should not exceed $1x10^{-9}$ cm^3/s.

NOTE: Contact INFICON if the leak rate exceeds $1x10^{-9}$ cm^3/s.

11 Install VCR-2 Ag-plated stainless steel gaskets (PN 059-0640) and the VCR-2 plugs in the service ports. When installing the gaskets, simultaneously use two wrenches to avoid stress and damage to the service ports. (Swagelok recommends tightening gaskets to 1/8 turn past finger-tight for stainless steel gaskets.)

WARNING

The service ports must be sealed for secondary containment to function in the event of a diaphragm leak.

7.3 Spare Parts

Table 7-1 Composer Elite spare parts

Part Number	Description
059-0196	VCR-4 Gasket, Ag-plated Ni
059-0215	VCR-4 Gasket, Ag-plated Ni, with Retainer (for ease of installation)
059-0266	VCR-4 Cap
059-0640	VCR-2 Gasket, Ag-plated Stainless Steel
059-0664	VCR-2 Plug
761-618-G1	Leak Test Needle Kit

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Chapter 8
Troubleshooting

8.1 Introduction

Troubleshoot Composer Elite problems by observing errors and warnings generated by the Sensor Control Unit (see section 8.2), or by consulting the diagnostic chart in section 8.3.

In some cases, returning the parameter values to factory default values may help in determining if a problem is hardware or process related. Refer to section 3.2.4, How To Revert To Factory Default Settings, on page 3-3.

If the problem cannot be resolved using the information provided in this chapter, refer to section 1.3, How To Contact INFICON, on page 1-4.

8.2 Errors and Warnings

Error and Warning codes can be obtained from any of the following:

- Errors and Warnings screen of the Sensor Control Unit (refer to section 3.3.2.5 on page 3-9)
- Composer Elite Multi-Sensor Software (refer to section 6.3.13, Composer Elite Multi-Sensor Software Warnings and Errors, on page 6-16)
- Remote communication status command S0 or S9 (refer to Table 5-21 on page 5-31, Table 5-22 on page 5-32, and Table 5-23 on page 5-34)

8.3 Troubleshooting Guide

Table 8-1 Troubleshooting Guide

Symptom	Possible Cause	Effect on Concentration	Remedy
CE Software - missing periods of frequency and concentration data	Unit was in Search mode during those periods	N/A	Data is not logged by the software while it is in the Search measurment mode as any data in this mode would have no meaning.
Error or Warning message(s) displayed	For Errors, refer to Table 5-22 on page 5-32. For Warnings, refer to Table 5-23 on page 5-34.	Various	Use Errors and Warnings tables to determine the cause and the approriate action to remedy the issue.
Concentration displays _ _ . _ _ _ _ Mole%	Flow requirements not met.	Invalid Concentration.	Confirm max./min. flow specifications are being met. see section 1.5.1, Composer Elite System Operating Specifications, on page 1-8).
	Electronics failure.	Invalid Concentration.	If symptom persists, contact INFICON.
Concentration displays _ _ . _ _ _ _ Mole% and Temperature displays 99.999°C	Interconnect cable disconnected.	Invalid Concentration	Check Interconnect cable connection. If symptom persists, contact INFICON.
Concentration offset (minimal) when the total gas flow through the Acoustic Sensor is varied.	Inlet and outlet tube connections reversed.	Concentration offset.	Reverse the connections to inlet and outlet tubes.
Concentration offset with barometric pressure change.	Loose plug on Acoustic Sensor service port.	Concentration offset.	Install new gasket (PN 059-0640) and tighten plug. Perform Reference Zero afterward (refer to section 3.2, Calibration, on page 3-2).

Table 8-1 Troubleshooting Guide

Symptom	Possible Cause	Effect on Concentration	Remedy
Concentration drift / offset	Reference Zero was performed before Acoustic Sensor was completely purged with a pure carrier gas (refer to section 4.1.10, What Happens if the Reference Zero is Improperly Set?, on page 4-8).	Concentration offset is equal to the residual precursor concentration at the time the Reference Zero was performed.	Thoroughly purge Acoustic Sensor with pure carrier gas and then perform Reference Zero (refer to section 3.2, Calibration, on page 3-2).
	Large barometric pressure change without performing Reference Zero.	Depends on magnitude of barometric pressure change.	Perform Reference Zero (refer to section 3.2, Calibration, on page 3-2).
	Reference Zero performed at inappropriate time.	Depends on magnitude of temperature change after Reference Zero was performed.	Wait for STEADY and AT TEMP indicators to appear and then allow additional time for maximum temperature stability before setting Reference Zero.
	Change of process pressure.	Refer to section 4.1.6, What is the Effect of Pressure Variation?, on page 4-4.	Perform Reference Zero (refer to section 3.2, Calibration, on page 3-2).
	Change of process flow.	Refer to section 4.1.7, What is the Effect of Flow Variation?, on page 4-5.	Perform Reference Zero (refer to section 3.2, Calibration, on page 3-2).

Table 8-1 Troubleshooting Guide

Symptom	Possible Cause	Effect on Concentration	Remedy
Concentration is noisy	Acoustically noisy environment.	Noisy Concentration.	Locate Acoustic Sensor farther from acoustic noise source or reduce acoustic noise. Acoustic sensor not mounted properly to a user supplied bracket or via mounting holes. see section 2.2.2, Installing The Acoustic Sensor, on page 2-9
	Electrically noisy environment.	Noisy Concentration.	Locate Acoustic Sensor and interconnect cable farther from electrical noise source. Proper Unit and Sensor grounding may not be in place or insufficent. see section 2.1.2.3, Composer Elite System Grounding Requirement, on page 2-4 for details on grounding.
	Electronics failure or Interconnect cable failure.	Noisy Concentration.	Exchange Interconnect cable. If symptom persists, contact INFICON.
	Maximum flow rate Exceeded or unstable.	Noisy Concentration.	Reduce flow rate to within specification (refer to section 1.5.1, Composer Elite System Operating Specifications, on page 1-8).
	Sensor Control Unit and/or Acoustic Sensor not properly grounded.	Noisy Concentration.	Check Sensor Control Unit and Acoustic Sensor grounding (refer to section 2.1.2, Grounding and Shielding, on page 2-3).
Oscillation("ringing") in Concentration	Poor pressure or flow control	Noisy Concentration.	see section 4.1.12, What would cause periods of oscillation in the concentration?, on page 4-10
	System failure.	Noisy Concentration.	Contact INFICON.

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Table 8-1 Troubleshooting Guide

Symptom	Possible Cause	Effect on Concentration	Remedy
Frequency display freezes the value.	System pressure outside of specified pressure range for Acoustic Sensor.	Invalid Concentration.	Change operating pressure (refer to section 1.5.1, Composer Elite System Operating Specifications, on page 1-8).
LCD display is dark.	Loss of power to Sensor Control Unit or electronics failure.	N/A.	Verify power switch is ON. Verify Mains power is present. Exchange external power supply. If symptom persists, contact INFICON.
Leak Test Procedure for primary chamber indicates a small leak (refer to section 7.2.1, Leak Testing the Primary (Resonant) Chamber, on page 7-1.	Diaphragm has small leak.	Concentration offset.	Contact INFICON.
Temperature readout exceeds 71°C and then displays 99.999°C until Acoustic Sensor cools to 71°C. Temperature cycling continues if cause is not resolved.	Electronics failure activated the Thermal Safety Switch.	Invalid Concentration.	Exchange Interconnect cable. If symptom persists, contact INFICON.
Temperature: ABOVE TEMP is constantly displayed.	Acoustic Sensor is located where ambient temperature exceeds Temperature Setpoint 1.	Invalid Concentration.	Increase Temperature Setpoint 1 to ambient temperature plus 5°C (refer to section 2.1.1.3, Heated Process Tubing and Acoustic Sensor Temperatures, on page 2-2).
Temperature: BELOW TEMP, NEAR TEMP, or ABOVE TEMP is displayed.	Temperature has not yet reached Temperature Setpoint 1.	Invalid Concentration.	Wait for STEADY and AT TEMP to appear (refer to section 3.2.3, How to Calibrate, on page 3-3).
Temperature: BELOW TEMP, NEAR TEMP, or ABOVE TEMP is displayed after AT TEMP was displayed.	Acoustic Sensor temperature changed from Temperature Setpoint 1.	Invalid Concentration.	Wait for STEADY and AT TEMP indicators to appear before performing Reference Zero (refer to section 3.2.3, How to Calibrate, on page 3-3).

Table 8-1 Troubleshooting Guide

Symptom	Possible Cause	Effect on Concentration	Remedy
Temperature setpoint 1 does not reach desired temperature	At lower temperature settings, heat from heater 2 may prevent heater 1 (temperature setpoint 1) from reaching the desired temperature	Invalid Concentration.	While typically temperature setpoint 2 is set 3ºC higher than setpoint 1, try lowering setpoint 2 to 1ºC higher.
	Electronics failure	Invalid Concentration.	contact INFICON.
Thickness and/or composition of film on substrate is incorrect.	Incorrect Molecular Weight and/or Gamma was entered.	Depends on magnitude of Wrong Molecular Weight / Gamma error.	Enter correct Molecular Weight and Gamma (refer to Table B-1 and section 4.1.4, What To Do when the Specific Heat Ratio for a Gas is Unknown, on page 4-3).

Chapter 9 Measurement and Theory

9.1 Speed of Sound and Gas Composition

The speed of sound, C, in an ideal gas is equal to:

$$C = \sqrt{\frac{\gamma RT}{M}} \quad [1]$$

where:

$$\gamma = \frac{C_p}{C_v} = \frac{\textit{Heat Capacity at Constant Pressure}}{\textit{Heat Capacity at Constant Volume}} = 1.4 \text{ for Air} \quad [2]$$

T = Kelvin temperature

R = Universal Gas Constant = 8.3143 x 10^7 erg/(Mole K)

M = Molecular Weight (AMU)

Equation [1] may be expanded for binary mixtures by modifying the Specific Heat Ratio and molecular weight to account for the Mole Fraction of component two, x, as follows.

$$\bar{\gamma} = 1 + \left[\frac{x}{\gamma_1 - 1} + \frac{1 - x}{\gamma_2 - 1}\right]^{-1} \quad [3]$$

$$\bar{M} = xM_1 + (1 - x)M_2 \quad [4]$$

So the speed of sound of the mixtures, C_M, is:

$$C_M = \sqrt{\frac{\bar{\gamma} RT}{\bar{M}}} \quad [5]$$

which holds for any ideal mixture; that is, a mixture that is formed without change in volume.

Composer Elite determines the speed of sound by precisely determining the gases' fundamental resonant frequency in a fixed chamber of length L. At resonance, a standing half wave exists in the Resonant Chamber, so the speed of sound and frequency are related as follows:

$$f = \frac{C}{2L} \quad [6]$$

In practice, the exact value of L is unimportant. Composition is computed from knowledge of the mixture's frequency relative to the frequency of the pure gas as follows. Let:

$$m = \frac{M_1}{M_2} \quad [7]$$

$$g = \frac{\gamma_1}{\gamma_2} \quad [8]$$

$$h = \frac{1}{\gamma_2} \quad [9]$$

Applying equations 7, 8, and 9 into equations 3 and 4 yields,

$$\overline{M} = M_2\{(m-1)x+1\} \quad [10]$$

$$\bar{\gamma} = 1 + \frac{\gamma_2\{(g-h)(1-h)\}}{\{x(1-g)+(g-h)\}} \quad [11]$$

If we define the speed of sound in the majority, or carrier, gas as C_2

$$C_2 = \sqrt{\frac{\gamma_2 RT}{M_2}} \quad [12]$$

and apply equations 9 and 10 into equation 4 we get:

$$c^2 = c_2^2\left(h + \frac{(g-h)(1-h)}{x(1-g)+(g-h)}\right)[1+(m-1)x]^{-1} \quad [13]$$

Since the speed of sound in a fixed resonator is directly proportional to the frequency of resonance, we define a ratio:

$$\lambda = \left(\frac{C}{C_2}\right)^2 = \left(\frac{f}{f_2}\right)^2 \quad [14]$$

Where f and f_2 are the resonant frequencies of the mixture and pure gas, respectively.

Combining 12, 13 and 14:

$$\lambda\{1+(m-1)x\} = \frac{[(g-h)(1-h)]}{[x(1-g)+(g-h)]} + h \quad [15]$$

Simplifying leads to,

$$Ax^2 + Bx + C = 0 \quad [16]$$

where,

$$A = \lambda(m-1)(1-g) \quad [17]$$

$$B = \lambda m(g-h) + \lambda(1-2g+h) - h(1-g) \quad [18]$$

$$C = (\lambda-1)(g-h) \quad [19]$$

Since the equation is quadratic, the solutions are of the following form,

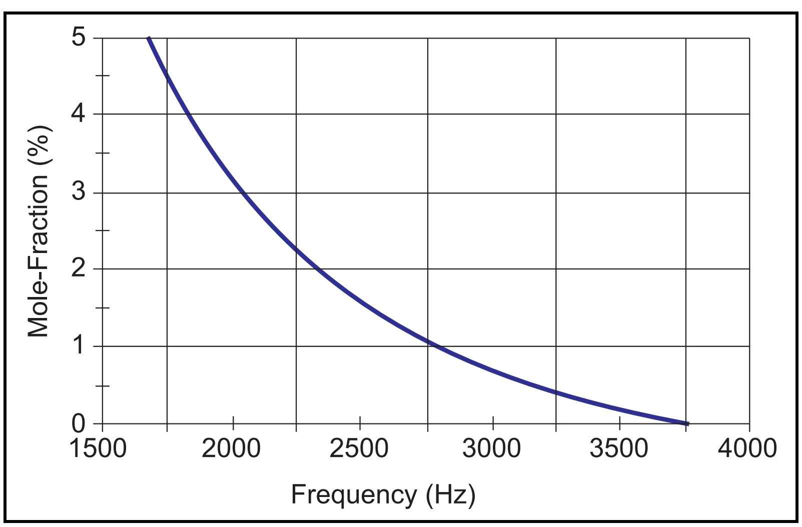
$$x_{1,2} = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A} \quad [20]$$

Since $x_{1,2}$ represents the Mole Fraction of the gases, acceptable solutions are,

$$0 \le x_{1,2} \le 1 \quad [21]$$

The general result of this analysis is that the technique is most sensitive to composition changes when the Molecular Weight difference between the carrier gas and the precursor is the greatest. See Figure 9-1.

Figure 9-1 Mole fraction of trimethylindium in H_2 vs. instrument's frequency



9.2 Measuring the Speed of Sound

A simple explanation of the functioning of Composer Elite is that it measures concentration by first determining the resonant frequency of the gas flowing through it and then comparing the measured resonant frequency to that of the pure carrier gas. Utilizing this frequency ratio, λ, and the physical parameters of the gases, m and γ, the concentration is derived. Composer Elite determines the basic resonant frequency by varying the frequency across the operating range and then operating at the frequency where the largest amplitude of sound is transmitted. Because the composition is controlled, or varies slowly, and the Resonant Chamber has good acoustic properties, the frequency may be measured with great precision. From equation [6] on page 9-2, the speed of sound may be derived from knowledge of the Resonant Chamber's length, L. In operation, the exact length is unimportant as only the ratio of frequencies, λ, is used to determine concentration.

One critical issue confronted in the measurement of the speed of sound is the ability to correctly measure or control the temperature of the gas. The Acoustic Sensor is designed to provide a user-set isothermal environment for gas in the Resonant Chamber and to precondition the gas as it enters the Resonant Chamber. To aid in this preconditioning, the Acoustic Sensor's inlet tubing is intentionally longer than is strictly necessary and is contained within the insulation of the Acoustic Sensor's enclosure. This helps smooth the gases' temperature transition from the temperature of the process tubing to the Resonant Chamber's carefully controlled temperature. There is a feedback loop between the temperature (Controlled Variable) as measured by a RTD, Platinum Resistance Thermometer, and the power level applied to the heaters (Manipulated Variable). It is normal for this temperature to be controlled to +/- 0.05°C. It is also normal for an offset to exist between the value of the temperature parameter and the actual temperature.

Measurement of the speed of sound is also dependent on the instrument's ability to precisely measure the amplitude of sound transmission through the Resonant Chamber. This is especially difficult as the pressure in the Resonant Chamber is lowered. Because of the need to operate some Delivery Systems at low pressures, a method was needed to couple energy more efficiently from the Excitation Microphone through the target media and into the Detecting Microphone. The use of a Helmholtz Resonator was chosen because its careful shaping allows relatively efficient energy coupling into the Resonant Chamber by providing a better impedance match. The Helmholtz design also provides a means of building a compact & low volume structure so that its Fundamental Resonance is at frequencies below the Self Resonance of both the Diaphragms and the Drive and Detecting Microphones.

A potential difficulty of operating at low frequencies is an apparent loss of frequency resolution (at least on a relative basis), when compared to operating at the frequencies produced by a high harmonic. But this is only an illusion. This apparent advantage is negated by modern electronics' ability to generate precision sine waves with resolutions of better than one part in 50,000. Improving the generation precision of the operating frequency to 0.1 Hz has the same effect on relative precision as operating in the tenth harmonic, without the viscous energy losses associated with the higher frequency sound waves. The basic measurement scheme employed is to generate a frequency and measure its amplitude. By intelligently varying the frequency it is easy to find the maximum amplitude, which corresponds to the Resonant Frequency. It is possible to further enhance the measurement system's resolution by methodically curve fitting the frequency vs. amplitude data around a Resonance peak to match a Lorentzian shape.

Another important aspect of Composer Elite design is that the concentration measurement does not depend on absolutes. How does this help? Think about the difficulty of measuring temperature to 0.01°C in an absolute sense. A quick review of the equations (section 9.1, Speed of Sound and Gas Composition, on page 9-1) shows that concentration measurement by this technique is dependent only on maintaining the temperature at the same temperature at which the reference zero measurement was taken. The RTD is a sensing element that is stable to fractions of a PPM per day, and all the relative error due to temperature variation is eliminated every time the instrument is zeroed. Likewise, the speed of sound depends slightly on the pressure, very slightly on the flow rate and even slightly on the local barometric pressure changes. Daily calibration, reestablishing Reference Zero, minimizes the possible influence of these variables on the concentration measurement.

9.3 Composer Elite Overview

The Composer Elite System Block Diagram (see Figure 9-2) depicts the general layout of the complete system.

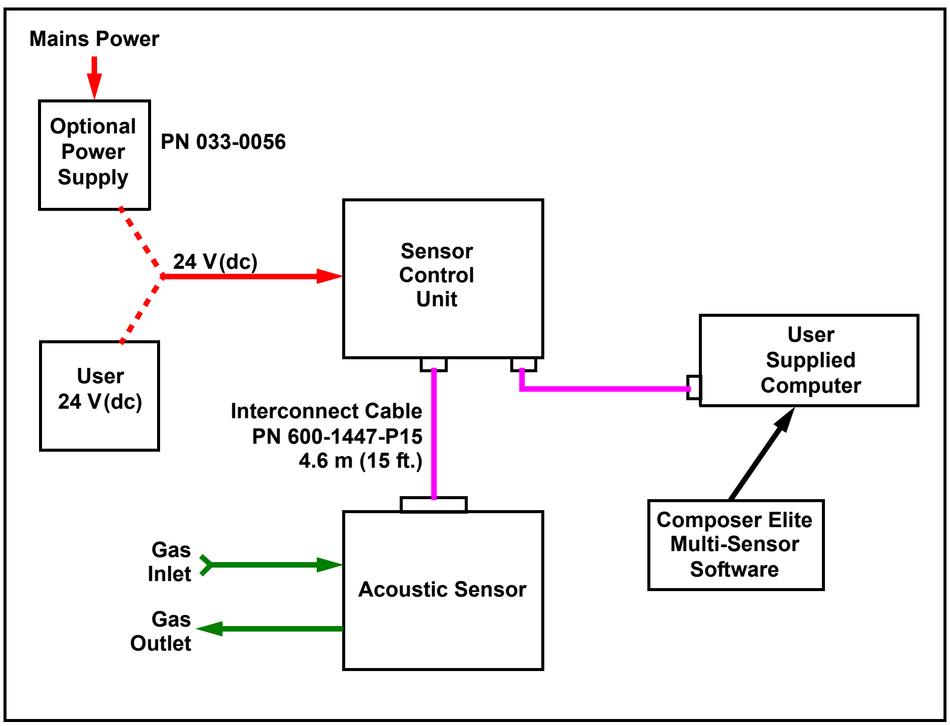
Overall layout depends on the convenient location of the Acoustic Sensor within the flow of the precursor delivery system.

The Sensor Control Unit may then be located up to 4.6 m (15 ft.) away from the Acoustic Sensor, either in a relay rack, table top, or deployed within the reactor.

Power is supplied either with the INFICON universal type power supply (option) or from a user-supplied 24 V (dc) regulated power supply.

Configuration data is provided at set up through the computer link and Composer Elite Multi-Sensor Software, or through the Sensor Control Unit front panel control knob and buttons.

Figure 9-2 Composer Elite System block diagram



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9.4 Description of Subsystems

Three major components comprise the Composer Elite System:

- Sensor Control Unit
- Multi-Sensor Software
- Acoustic Sensor

9.4.1 Sensor Control Unit and Composer Elite Multi-Sensor Software

The Sensor Control Unit provides all necessary power and electrical signals to the acoustic sensor, performs all signal processing and stores all parameter values necessary to calculate concentration.

Composer Elite Multi-Sensor Software works in conjunction with the Sensor Control Unit to allow remote operation from a computer.

- Refer to section 1.5.2 on page 1-9 for information on the Sensor Control Unit.
- Refer to Chapter 6 for information on the Composer Elite Multi-Sensor Software.

9.4.2 Acoustic Sensor

The basic Acoustic Sensor element is the resonant chamber with the inlet and outlet tubes providing a means of transporting the gases from the process tubing, through the Acoustic Sensor's case and finally connecting to the structure that defines the shaped resonant chamber (see Figure 9-3 and Figure 9-4 on page 9-9). Because the speed of sound in a gas is dependent on its temperature, there is a mechanism to measure and control the temperature. First, a platinum resistance thermometer, or RTD, is imbedded into the chamber body. Heater elements are able to provide a "heat only" means of control. The RTD and heaters are connected in a feedback control loop that is monitored and executed by the Sensor Control Unit portion of the Composer Elite System. A thermo-mechanical switch is attached to the chamber body and automatically interrupts the heaters' current should there ever be a fault that would allow the temperature to exceed 71°C (75°C for the inlet tube heater). Both ends of the resonant chamber are defined by a tensioned diaphragm. This diaphragm is used to safely seal the chamber and also to provide a level of flexibility sufficient to impose an acoustic wave on one end and to allow its transport and detection outside the resonant chamber on the other end.

The function of all of the above component elements is to provide an ideal environment for transporting and measuring speed of sound through the resonant chamber.

The sending microphone cartridge provides the source of acoustic energy to excite the diaphragm. It is designed to effectively couple acoustic energy into the diaphragm yet not couple energy into the chamber body. It uses a pair of flat response electro-dynamic microphones to accomplish this. This cartridge is powered by the Sensor Control Unit portion of the Composer Elite System.

The receiving microphone cartridge is used for detection of the acoustic energy transported across the resonant chamber and through the diaphragm. It is a wide response electret type with a built in FET amplifier. Its signal is amplitude detected by the Sensor Control Unit portion of the Composer Elite System.

Figure 9-3 Acoustic sensor main components 1

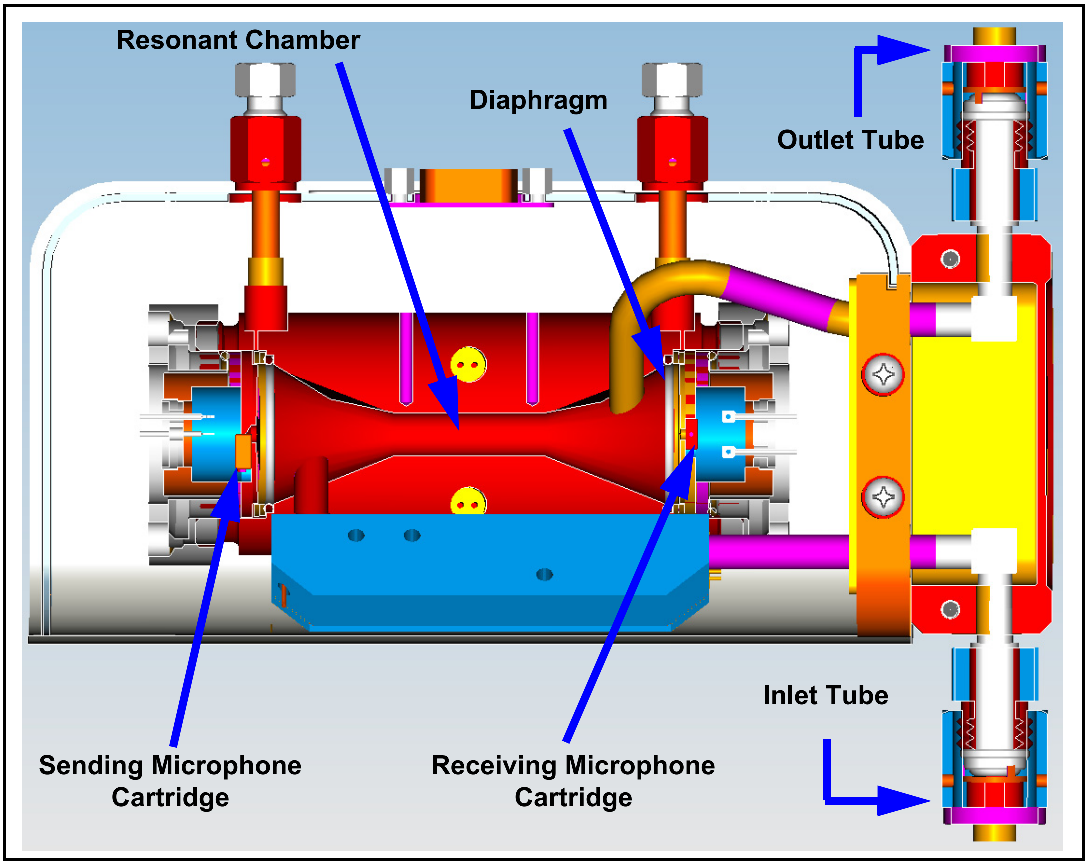

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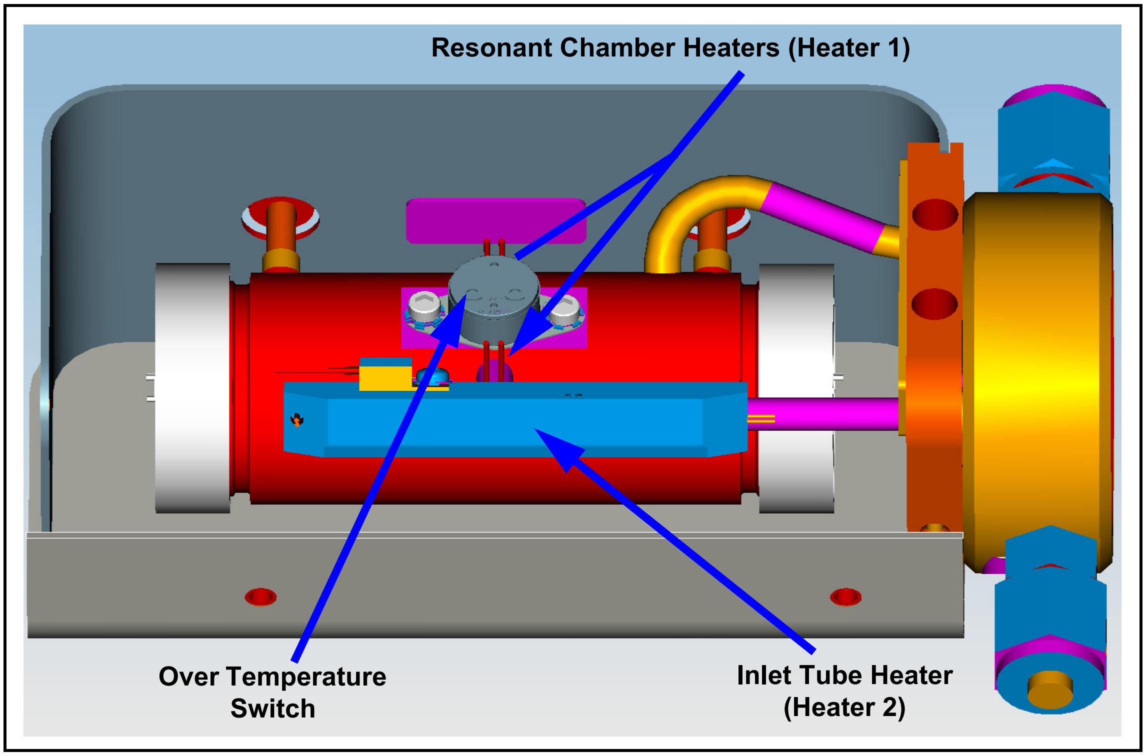
Figure 9-4 Acoustic sensor main components 2



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Appendix A
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Appendix B
Material Table

B.1 Introduction

Table B-1 represents the Molecular Weight and Gamma Factor for various materials. The list is in alphabetical order by gas name.

CAUTION

Some of these materials are toxic. Please consult their appropriate material safety data sheet and safety instructions before use.

Table B-1 Material table

Gas Name	Formula	Molecular Weight	Gamma Factor
ammonia	NH_3	17.030	1.316
argon	Ar	39.948	1.667
arsine	AsH_3	77.950	1.269
bis-cyclopentadienylmagnesium	Cp_2Mg	154.490	1.061
carbon dioxide	CO_2	44.010	1.288
carbon tetrabromide	CBr_4	331.627	1.100
cupra-select	$Cu(C_{10}H_{13}F_6O_2Si)$	370.830	1.052
deuterium	D	4.032	1.398
diborane	B_2H_6	27.670	1.165
diethyl tellurium	DETe	185.720	1.100
dimethylhydrazine	DMHy	60.100	1.160
dimethyl zinc	DMZn	95.450	1.120
dimethyl zinc(2)	TEAM-DMZn	196.650	1.100
ethyl lactate	$C_5H_{10}O_3$	118.100	1.140
germanium chloride	$GeCl_2$	214.404	1.097
helium	He	4.003	1.630
hydrogen	H_2	2.016	1.404
methyl hydrazine	$N_2H_2(CH_3)_2$	60.100	1.160

Table B-1 Material table (continued)

Gas Name	Formula	Molecular Weight	Gamma Factor
nitrogen	N_2	28.010	1.399
oxygen	O_2	32.000	1.395
phosphoryl trichloride	$POCl_3$	153.330	1.168
silicon chloride hydride	SiHCl3	135.450	1.123
silicon fluorine hydrogen	$SiFH_3$	50.100	1.213
silicon hexafluride	SiF_6	142.080	1.127
silicon tetrachloride	$SiCl_4$	169.900	1.101
silicon tetrabromide	$SiBr_4$	347.702	1.094
tetraethyl orthosilicate	TEOS	208.260	1.200
tetrafluoroethane	R134a	102.000	1.120
tetrakis(diethylamino)titanium	TDEAT	336.100	1.200
tetrakis(dimethylamido)titanium	TDMAT	224.000	1.200
trichlorosilane	$SiHCl_3$	135.450	1.123
triethylgallium	TeGa	156.930	1.120
trimethylaluminum	TMAl	72.090	1.230
trimethylgallium	TMGa	114.830	1.103
trimethylindium	TMIn	159.93	1.120
tungsten hexafluoride	WF_6	297.830	1.075

Appendix C
Outline Drawings

C.1 Composer Elite Acoustic Sensor

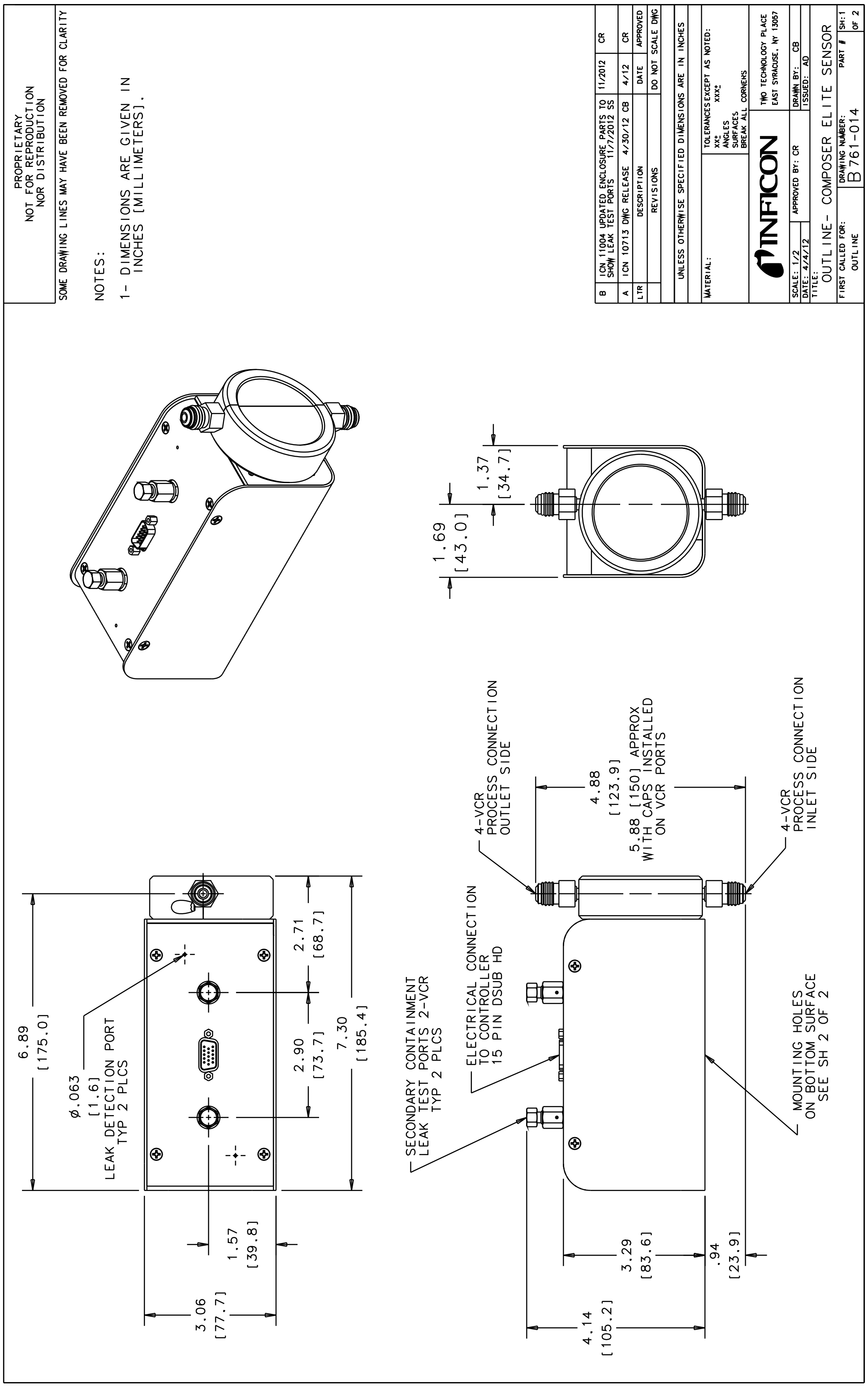

Figure C-1 761-014-1-b-outl Outline Composer Elite Sensor Page 1 of 2

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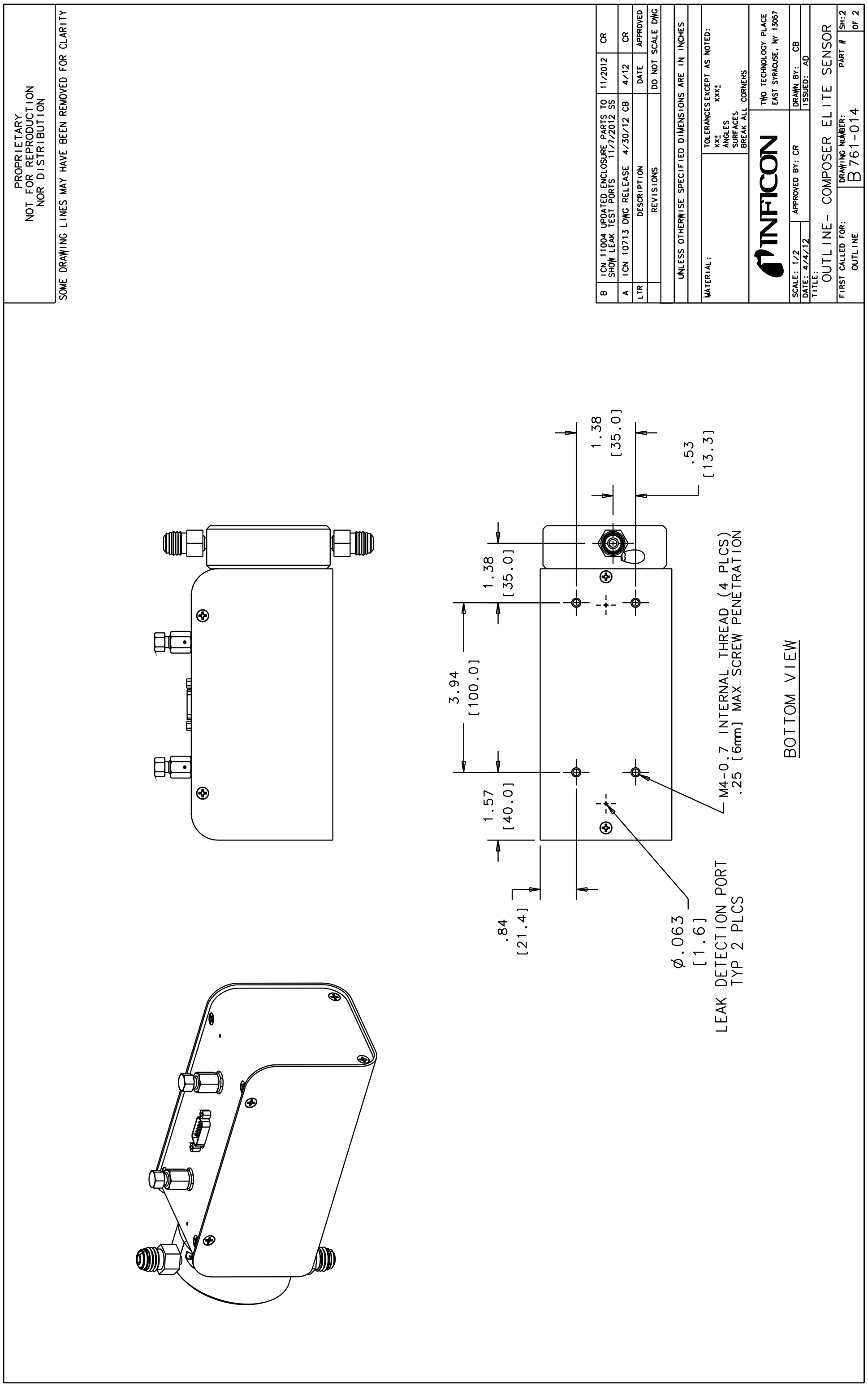

Figure C-2 761-014-2-b-outl Outline Composer Elite Sensor Page 2 of 2

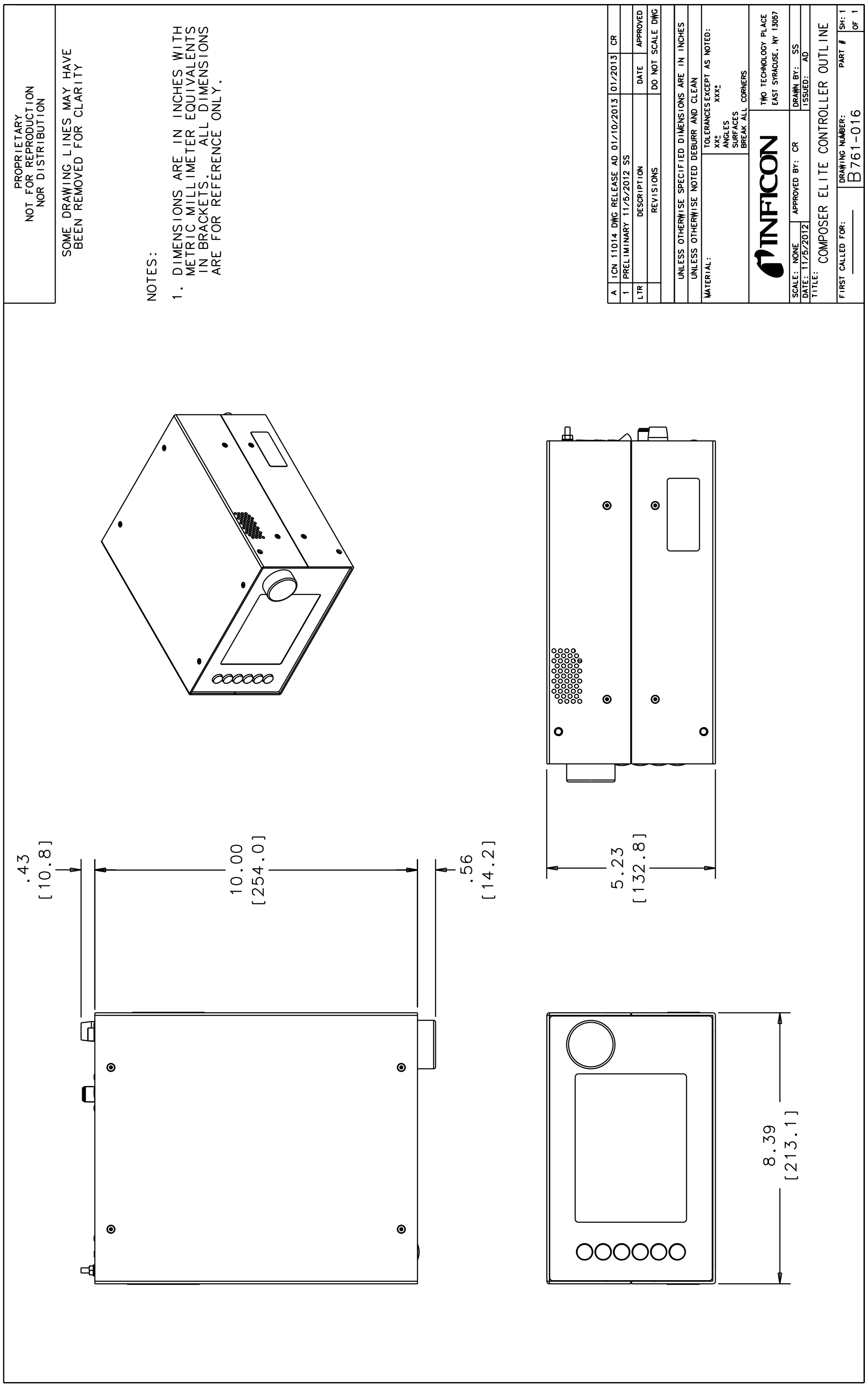

Figure C-3 761-016-1-outl Composer Elite Controller Outline