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

Cool Drawer™

Single and Dual Sensors

PN 074-609-P1A

INFICON

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Cool Drawer™

Single and Dual Sensors

PN 074-609-P1A

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www.inficon.com   reachus@inficon.com

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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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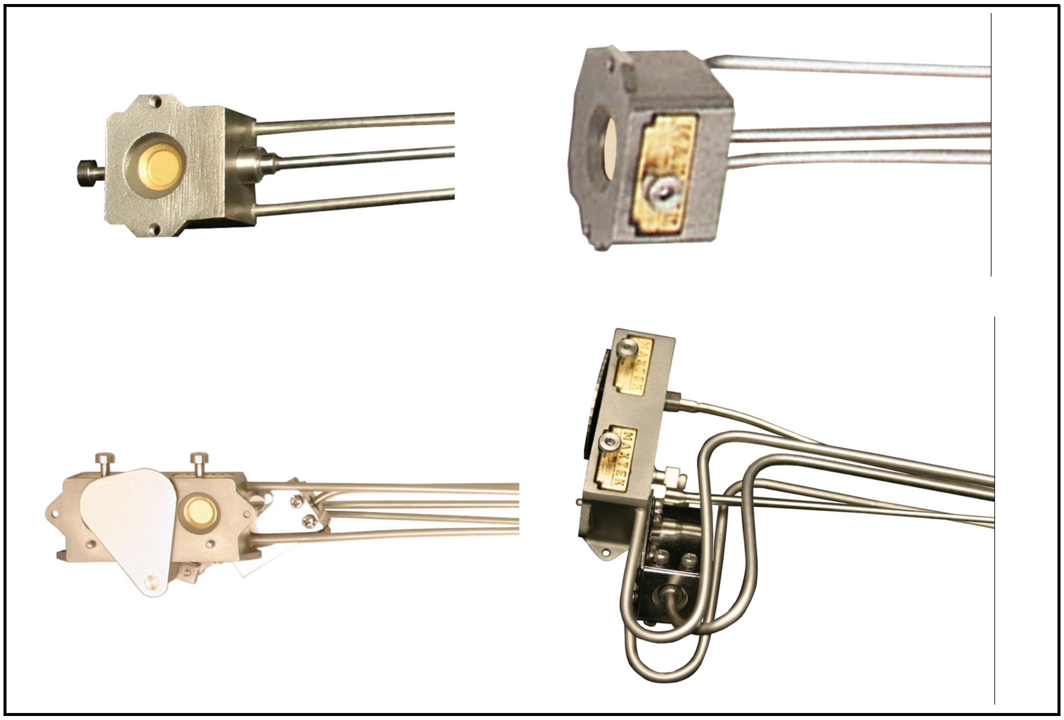
Chapter 1
Introduction

1.1 Introduction

INFICON Cool Drawer™ sensors, see Figure 1-1, offer proven reliability and durability combined with excellent thermal stability. The Cool Drawer design allows crystal installation into the sensor from the side, convenient for systems with insufficient room for front load crystal installation. Sensors can be ordered in a sensor and feedthrough combination that can be either welded or assembled with O-ring compression fittings.

Figure 1-1 Cool Drawer sensors



The Cool Drawer sensor comes in two styles: Single or Dual. Each style is available in both Standard and Right Angle orientation.

- Standard orientation: Cooling tubes are aligned parallel to the crystal face. Typically installed from the side or bottom of the chamber.
- Right Angle orientation: Cooling tubes are aligned perpendicular to the crystal face. Typically installed from the top of the chamber.

Sensors can be ordered with a pneumatically driven crystal shutter to protect the crystal during source warm up, or when the sensor is not used during deposition of an alternate material, or to extend crystal life when used with sampling.

NOTE: A crystal shutter is standard on dual sensors.

1.2 Definition of Notes, Cautions and Warnings

Before using this manual, please take a moment to understand the Cautions and Warnings used throughout. They provide pertinent information that is useful in achieving maximum instrument efficiency while ensuring personal safety.

NOTE: Notes provide additional information about the current topic.

CAUTION

Failure to heed these messages could result in damage to the sensor.

WARNING

Failure to heed these messages could result in personal injury.

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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 experiencing a problem with a Cool Drawer Sensor, please have the following information readily available:

- The Lot Identification Code, located on the side surface of the sensor head.
- A description of the problem.
- An explanation of any attempts at corrective action.
- Exact wording of any error messages received.

1.3.1 Returning Cool Drawer Sensor to INFICON

Do not return any component of the sensor to INFICON without first speaking with a Customer Support Representative. A Return Material Authorization (RMA) number must be obtained from the Customer Support Representative.

If a package is delivered to INFICON without an RMA number, the package will be held and customer contact will be made. This will result in delays in servicing the sensor.

Prior to being given an RMA number, a Declaration Of Contamination (DOC) form may need to be completed if the sensor has been exposed to process materials. DOC forms must be approved by INFICON before an RMA number is issued. INFICON may require that the sensor be sent to a designated decontamination facility, not to the factory.

1.4 Unpacking and Inspection

1 If the Cool Drawer sensor has not been removed from its packaging, do so now. The sensor and accessories are packaged in a single cardboard carton with a rigid foam insert. Carefully remove the packaged accessories before removing the sensor.

2 Carefully examine the sensor for damage that may have occurred during shipping. This is especially important if obvious rough handling is noticed on the outside of the container. *Immediately report any damage to the carrier and to* INFICON.

NOTE: Do not discard the packing materials until inventory has been taken and the sensor has been successfully installed.

3 Take an inventory of the order by referring to the order invoice and the information contained in section 1.5.5 or section 1.6.4.

4 Install the sensor by following the installation instructions found in Chapter 2, Sensor Installation.

For additional information or technical assistance, contact INFICON (refer to section 1.3 on page 1-3).

1.5 Cool Drawer Single Sensor (PN CDS-XXXXX)

Figure 1-2 Standard sensor

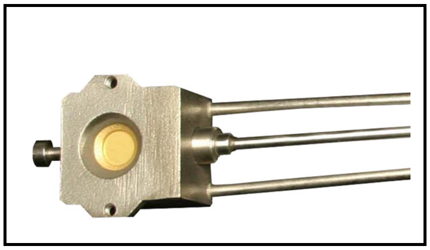
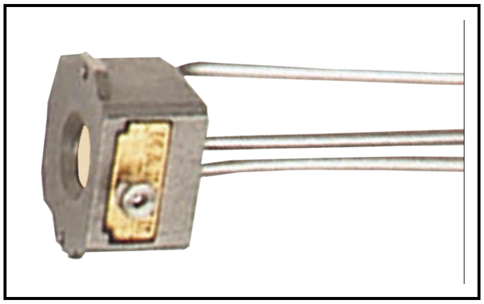


Figure 1-3 Right Angle sensor



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1.5.1 Specifications

Maximum bakeout temperature with no water

O-ring compression fitting terminations . . . . .165°C

Welded terminations. . . . . .200°C

Maximum operating isothermal environment temperature with minimum water flow

O-ring compression fitting terminations . . . . .300°C

Welded terminations. . . . . .450°C

1.5.1.1 Size

Maximum envelope without shutter . . . . **Standard Sensor**
3.38 x 3.07 x 1.80 cm
(1.33 x 1.21 x 0.71 in.)
See Figure 1-5 on page 1-9.
Right Angle Sensor
3.24 x 3.63. x 1.80 cm
(1.27 x 1.43 x 0.71 in.)
See Figure 1-5 on page 1-9.

Length of sensor. . . . . 10.2 to 66.0 cm (4 to 26 in.)

Water and conduit tubes. . . . . 3.175 mm (1/8 in.) OD seamless stainless steel, 0.406 mm (0.016 in.) wall thickness

Crystal exchange . . . . Side loading, self-contained package

Crystal . . . . 14 mm (0.550 in.) diameter

Mounting. . . . . Two #4-40 tapped holes on the back of the sensor body

1.5.2 Installation Requirements

Feedthrough . . . . INFICON provided CF40 feedthrough or 2.54 cm (1 in.) bolt feedthrough

Other . . . . XIU or oscillator to match specific controller/monitor
CDS-X1XXX only: Solenoid Valve for air PN 750-420-G1 (see section 3.1 on page 3-1)

Water Flow Rate . . . . Minimum 150 to 200 cm^3/min, 30°C maximum

Water Quality . . . . Coolant should not contain chlorides as stress corrosion cracking may occur. Extremely dirty water may result in loss of cooling capacity.

CAUTION

Do not allow water tubes to freeze. This may happen if the tubes pass through a cryogenic shroud and the flow of fluid is interrupted.

Air (shutttered sensors only) . . . . . . 55 PSIG {70 PSIA} (3.8 bar) [379 kPa](minimum)

60 PSIG {75 PSIA} (4.1 bar) [414 kPa](maximum)

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

1.5.3 Materials

Body and Drawer . . . . Stainless steel, gold plated Cool Drawer

Springs, Electrical Contacts . . . . Au plated Be-Ni

Water and conduit tubes . . . . 304 stainless steel

Wire . . . . Silicon insulated copper

Braze . . . . Vacuum process high temperature Ni-In

1.5.4 Specifications for the Single Shutter

Temperature . . . . 165°C (300°C if properly attached to water cooled sensor)

Air Tube . . . . SS-104, 3.175 mm (1/8 in.) OD x 0.381 mm (0.015 in.) wall thickness seamless stainless steel

Materials. . . . . 100 series stainless steel

Pressure . . . . 55 PSIG {70 PSIA} (3.8 bar) [379 kPa] (minimum)

60 PSIG {75 PSIA} (4.1 bar) [414 kPa] (maximum)

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

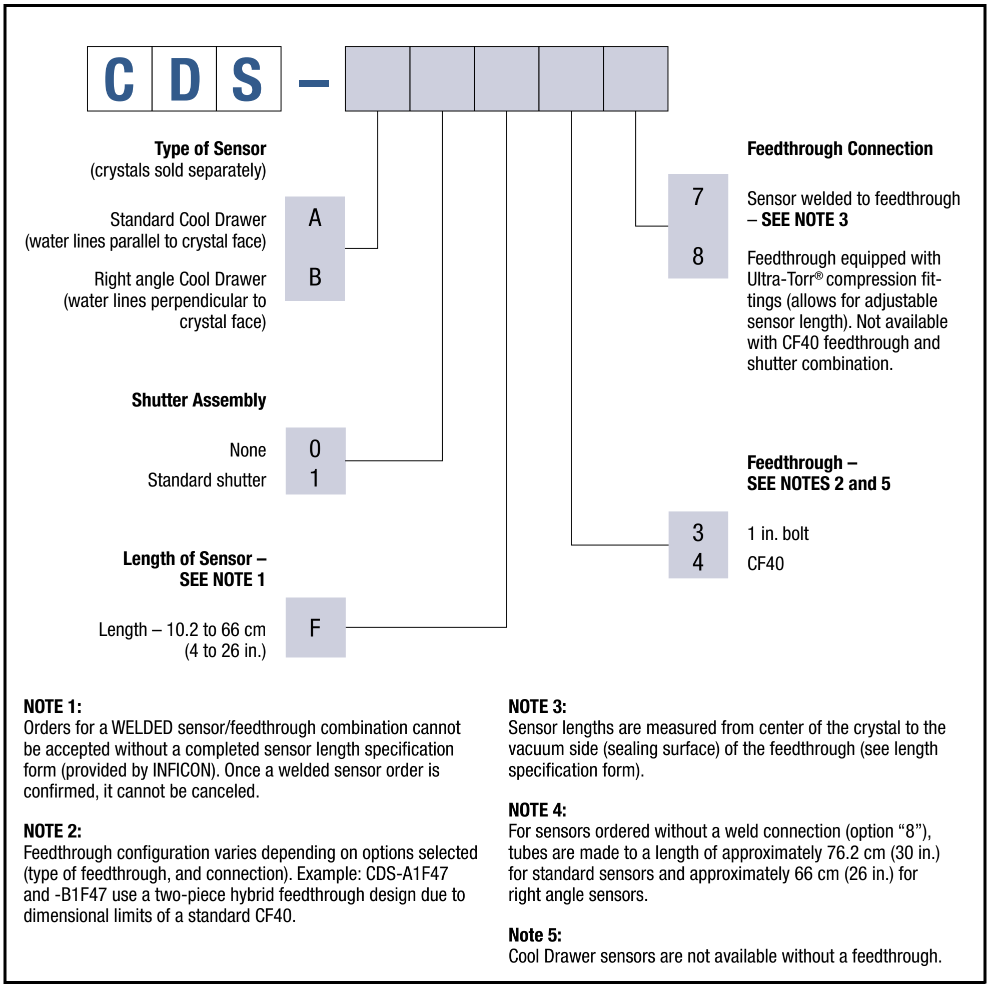
Shutter . . . . Pneumatically operated. Shutter swings aside for easy crystal exchange.

Braze . . . . Vacuum process high temperature (Ni-Cr alloy)

1.5.5 Parts and Options Overview (Single Sensor)

Cool Drawer Single Sensor . . . . **CDS-XXXXX** (See Figure 1-4)

Figure 1-4 Cool Drawer single sensor configurations



1.5.6 Single Sensor Drawings

The following single sensor outline drawings provide dimensions and other relevant data necessary for planning equipment configurations.

Figure 1-5. . . . . Cool Drawer Sensors with 2.54 cm (1 in.) bolt and O-ring compression fittings

Figure 1-6. . . . . Cool Drawer sensors welded to CF 40

Figure 1-7. . . . . Standard Cool Drawer sensor length with shutter

Figure 1-8. . . . . Right Angle Cool Drawer sensor length with shutter

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Figure 1-5 Cool Drawer sensors with 2.54 cm (1 in.) bolt and compression fittings

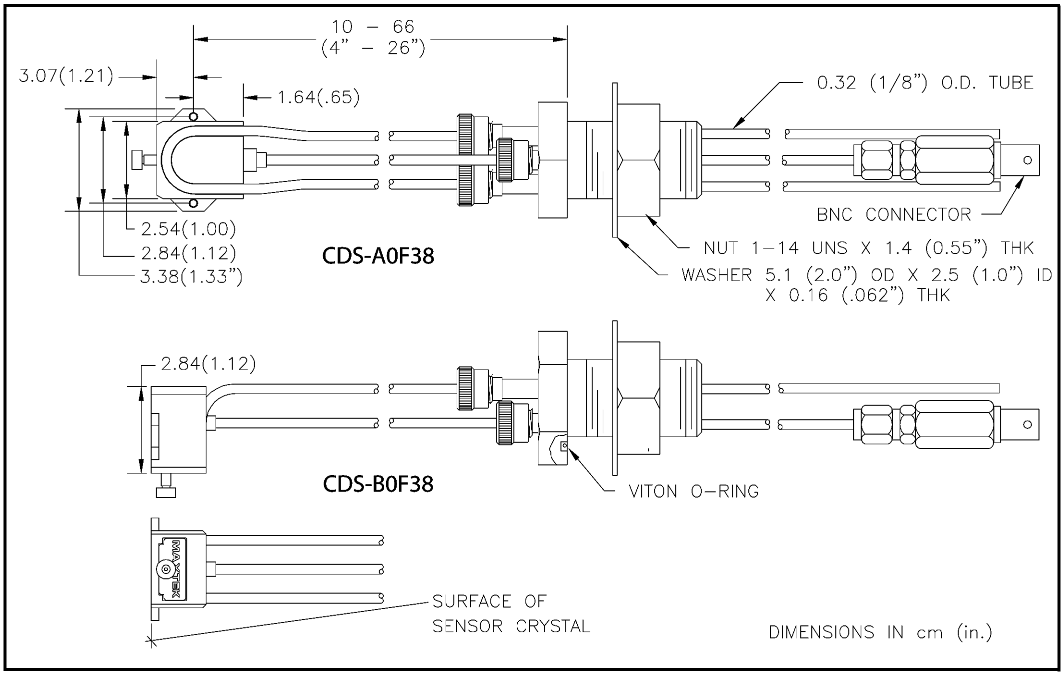


Figure 1-6 Cool Drawer sensors welded to CF 40

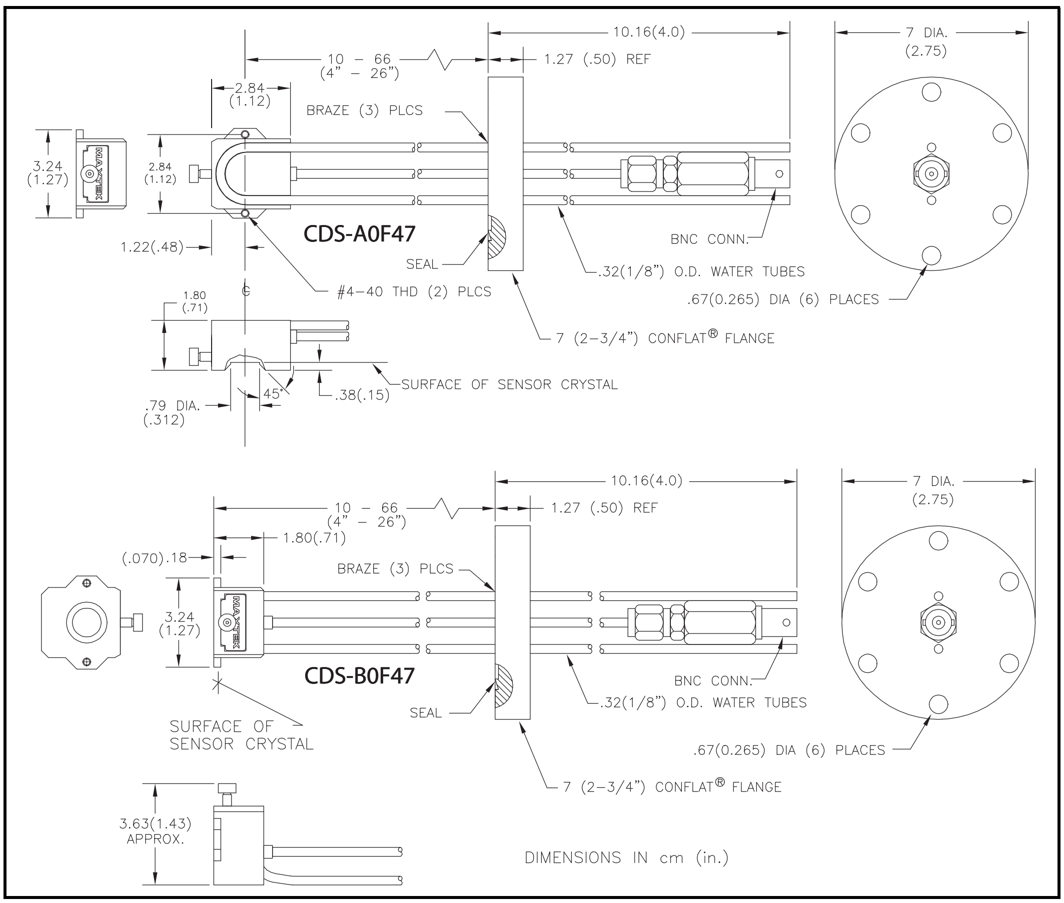


Figure 1-7 Standard Cool Drawer sensor length with shutter

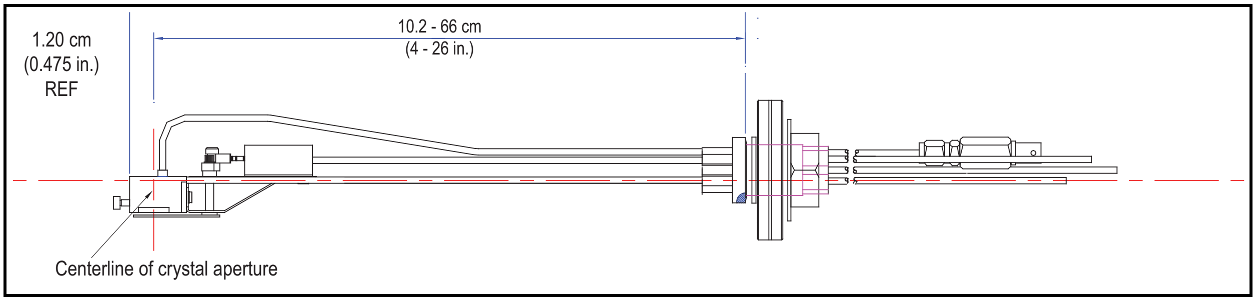
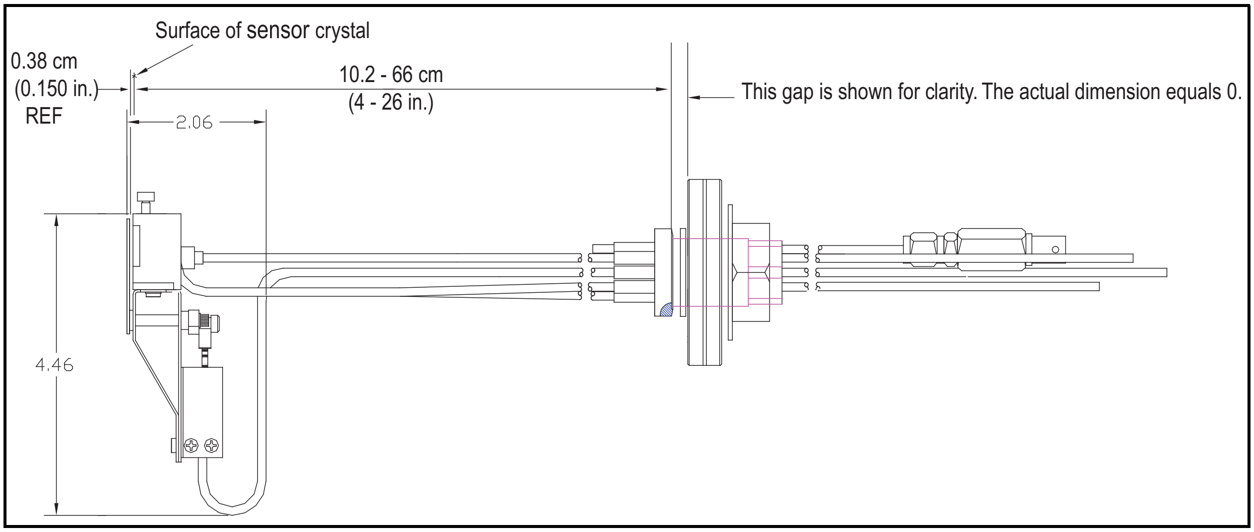
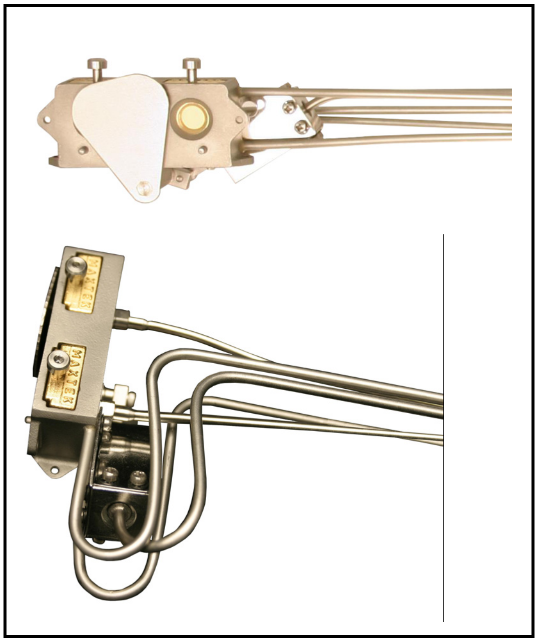


Figure 1-8 Right Angle Cool Drawer sensor length with shutter



1.6 Cool Drawer Dual Sensor (PN CDD-XXXX)

Figure 1-9 Cool Drawer dual crystal sensor



1.6.1 Specifications

Maximum bakeout temperature with no water

O-ring compression fitting terminations . . . . 165°C
Welded terminations. . . . . 200°C

Maximum operating isothermal environment temperature with minimum water flow

O-ring compression fitting terminations . . . . 300°C
Welded terminations. . . . . 450°C

1.6.1.1 Size

Maximum envelope without shutter	**Standard Sensor** 4.70 x 6.35 x 5.08 cm (1.85 x 2.50 x 2.00 in.) Figure 1-11 on page 1-15 **Right Angle Sensor** 4.70 x 10.54 x 4.45 cm (1.85 x 4.15 x 1.75 in.) Figure 1-11 on page 1-15
Length of sensor	10.2 to 66.0 cm (4 to 26 in.)
Water and conduit tubes	3.175 mm (1/8 in.) OD seamless stainless steel, 0.406 mm (0.016 in.) wall thickness
Crystal exchange	Side loading, self-contained package
Crystal	14 mm (0.550 in.) diameter
Mounting	Four #4-40 tapped holes on the back of the sensor body

1.6.2 Installation Requirements

Feedthrough . . . . INFICON provided CF40 feedthrough or 2.54 cm (1 in.) bolt feedthrough

Other . . . . XIU or oscillator to match specific controller/monitor
Solenoid Valve for air
PN 750-420-G1 (see section 3.1 on page 3-1)

Water Flow Rate. . . . . Minimum 150 to 200 cm^3/min, 30°C maximum

Water Quality . . . . Coolant should not contain chlorides as stress corrosion cracking may occur. Extremely dirty water may result in loss of cooling capacity.

CAUTION

Do not allow water tubes to freeze. This may happen if the tubes pass through a cryogenic shroud and the flow of fluid is interrupted.

Air . . . . 55 PSIG {70 PSIA} (3.8 bar) [379 kPa](minimum)

60 PSIG {75 PSIA} (4.1 bar) [414 kPa](maximum)

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

1.6.3 Materials

Body and Drawer . . . . Stainless steel, gold plated Cool Drawer

Springs, Electrical Contacts . . . . Au plated Be-Ni

Water and conduit tubes. . . . . 304 stainless steel

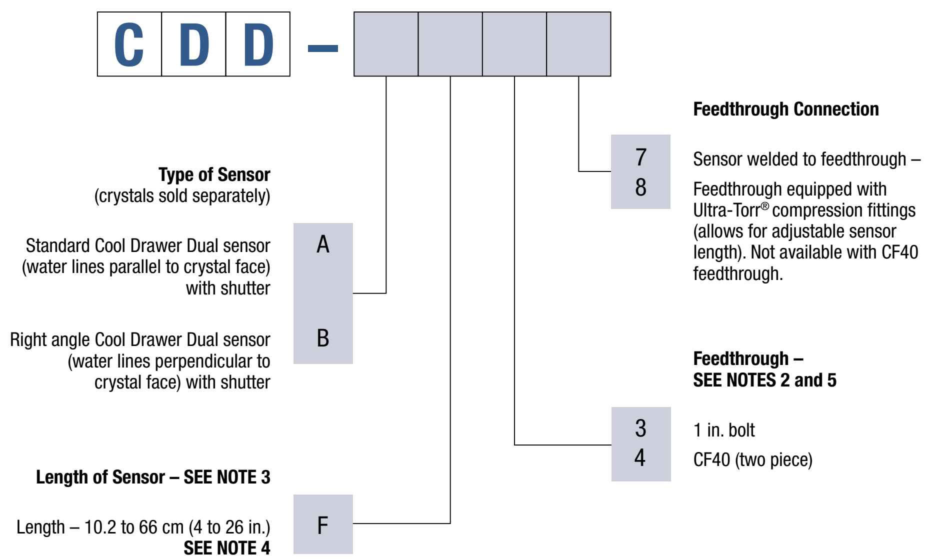
Wire . . . . Silicon insulated copper

Braze . . . . Vacuum process high temperature Ni-In

1.6.4 Parts and Options Overview (Dual Sensor)

Cool Drawer Dual Sensor . . . . **CDD-XXXX** (See Figure 1-10)

Figure 1-10 Cool Drawer dual sensor configurations



NOTE 1:
Orders for a WELDED sensor/feedthrough combination cannot be accepted without a completed sensor length specification form (provided by INFICON). Once a welded sensor order is confirmed, it cannot be canceled.

Note 2:
Feedthrough configuration varies depending on options selected (type of feedthrough, and connection). Example: CDD-AF47 and -BF47 use a two-piece hybrid feedthrough design due to dimensional limits of a standard CF40.

Note 3:
Sensor lengths are measured from center of the crystal closest to the end of the sensor to the vacuum side (sealing surface) of the feedthrough (see length specification form).

Note 4:
For sensors ordered without a weld connection (option “8”), tubes are made to a length of approximately 76.2 cm (30 in.) for standard sensors and approximately 66 cm (26 in.) for right angle sensors.

Note 5:
Cool Drawer sensors are not available without a feedthrough.

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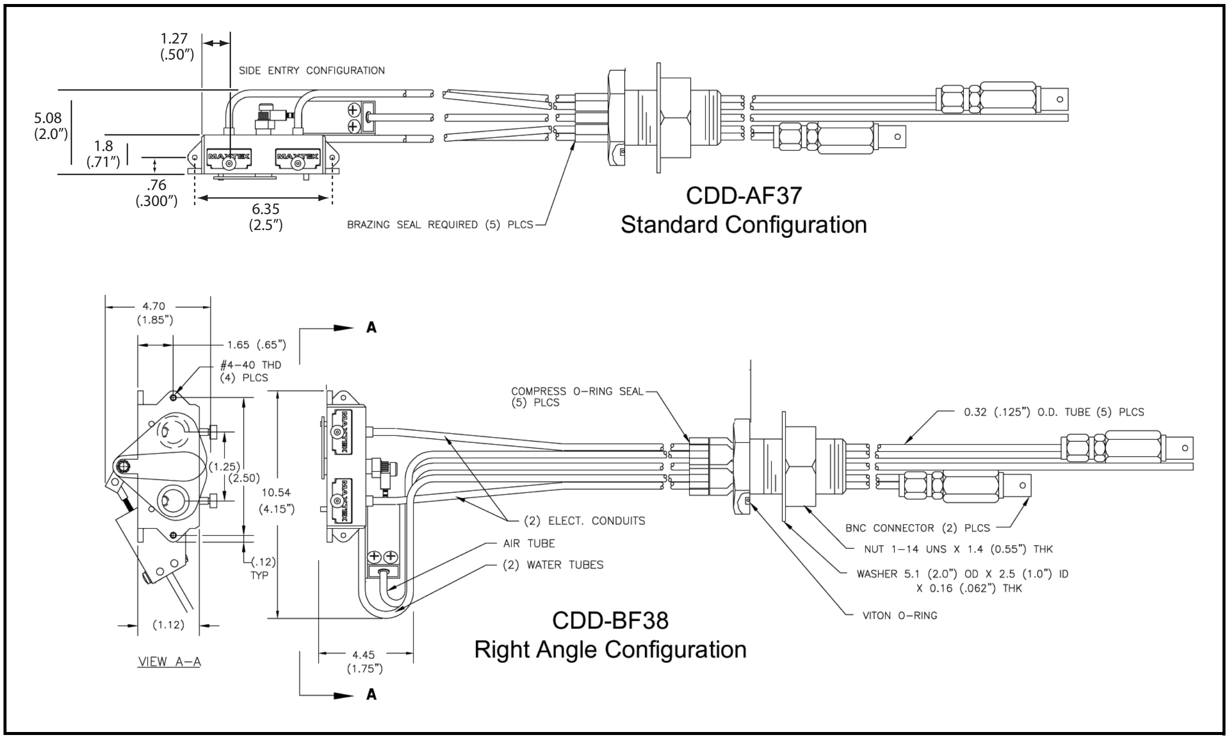
1.6.5 Dual Sensor Drawings

Figure 1-11 displays Standard and Right Angle dual sensor outline drawings which provide dimensions and other relevant data necessary for planning equipment configurations.

Figure 1-11 Standard and Right Angle configuration Cool Drawer dual sensors



1.7 Replacement Parts and Accessories

Retainer Assembly with Ceramic Insulator. . . . . .PN 123259

Crystal Drawer and Retainer Assembly
(Includes 123259 and 123261). . . . . .PN 123260

Crystal Drawer . . . . .PN 123261

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Chapter 2
Sensor Installation

2.1 Pre-installation Sensor Check

Prior to installing the sensor in the vacuum system, make certain that it is in proper working condition by following the appropriate procedure.

CAUTION

The sensor head, water tube, etc., should be clean and free of grease when installed in the vacuum chamber. Clean nylon gloves should be worn while handling. If parts do become contaminated, clean them thoroughly using a suitable solvent to avoid outgassing.

2.1.1 Sensor Installation with a XTC/3™, IC6™ or Cygnus 2™ Deposition Controller

1. Connect one end of the 15.2 cm (6 in.) BNC cable (PN 755-257-G6) to the BNC connector on the feedthrough.
2. Connect the other end of the 15.2 cm (6 in.) BNC cable to the connector of the Modelock oscillator (XIU) (PN 781-600-GX).
3. Connect one end of the XIU cable (PN 600-1261-GXX) to the mating connector of the XIU.
4. Connect the other end of the XIU cable to a sensor channel at the rear of the controller.
5. Install the crystal as instructed by section 4.4 on page 4-10.
6. Connect power to the controller.
7. Set the power switch ON.
8. Set density at 1.00 g/cm^3.
9. Zero thickness.
10. The display should indicate 0 or ±0.001 kÅ.
    Crystal life should read from 0 to 5%.
11. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should appear on the display. When the moisture evaporates, the thickness indication should return to approximately zero.

If the above conditions are observed, the sensor is in proper working order and may be installed.

2.1.2 Sensor Installation with a SQM-160™, SQC-310™, SQM-242™, IQM-233™, STM-2XM™, or STM-3™ Deposition Controller/Monitor

1. Connect one end of the 15.2 cm (6 in.) BNC cable (PN 782-902-011) to the BNC connector on the feedthrough.
2. Connect the other end of the 15.2 cm (6 in.) BNC cable to the connector of the oscillator (PN 782-900-010 or 783-500-013) labeled "Feedthrough" or "Sensor."
3. Connect one end of the oscillator cable (PN 782-902-012-XX) to the mating connector of the oscillator labeled "Instrument" or "Control Unit."
4. Connect the other end of the oscillator cable to a sensor connector at the rear of the controller/monitor.
5. Install the crystal as instructed by section 4.4 on page 4-10.
6. Connect power to the controller.
7. Set the power switch ON.
8. For the SQM-242 or IQM-233 card, launch the appropriate software.
9. Set density at 1.00 g/cm^3.
10. Zero thickness.
11. The display should indicate 0 or ±0.001 kÅ.
    Crystal life should read from 95% to 100%.
12. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should appear on the display. When the moisture evaporates, the thickness indication should return to approximately zero.

If the above conditions are observed, the sensor is in proper working order and may be installed.

2.1.3 Sensor Installation with a Q-pod™ or STM-2™ Deposition Monitor

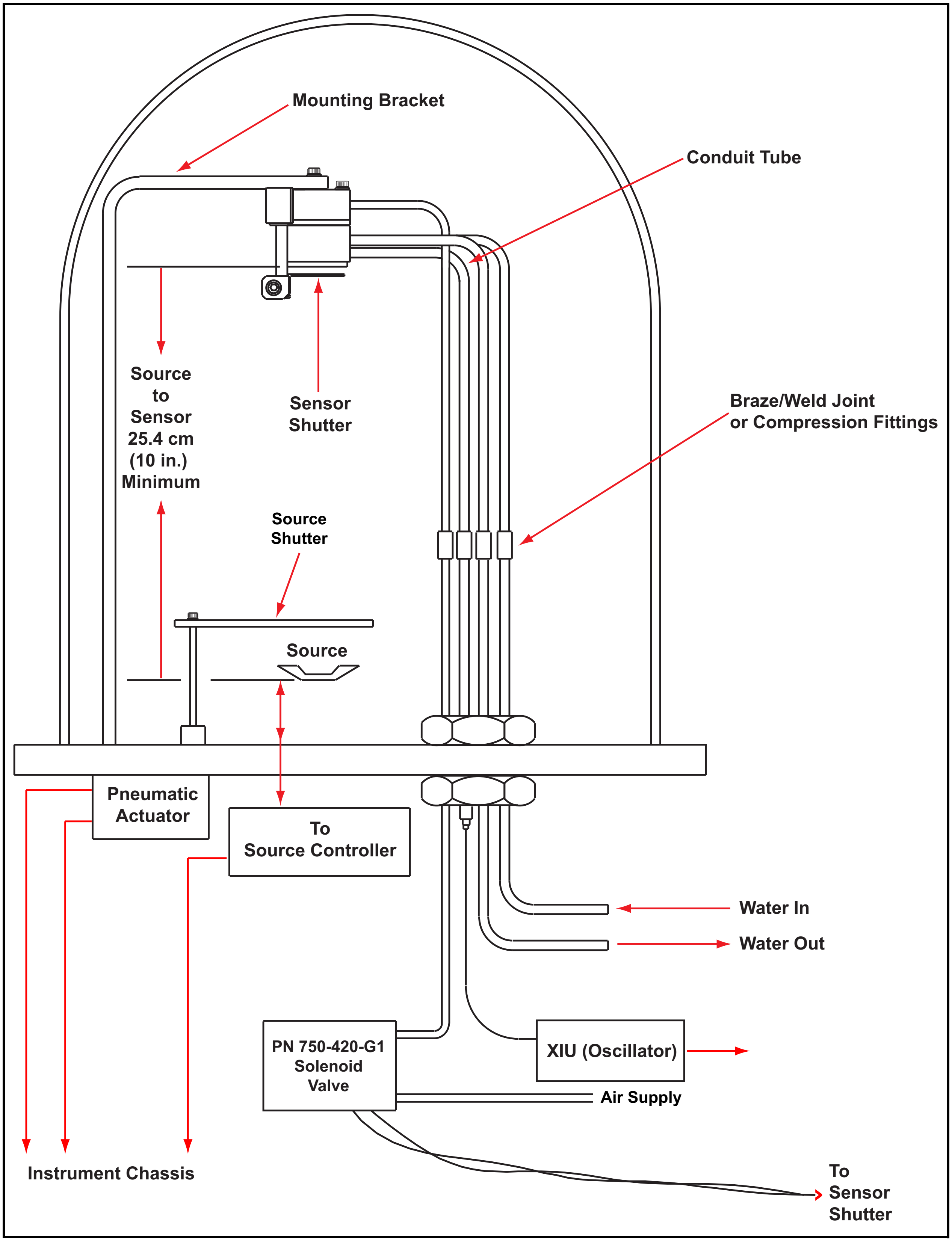
1. Connect one end of the 15.2 cm (6 in.) BNC cable (PN 782-902-011) to the BNC connector on the feedthrough.
2. Connect the other end of the 15.2 cm (6 in.) BNC cable to the connector on Q-pod or STM-2.
3. Connect one end of the USB cable (PN 068-0472) to the mating connector on Q-pod or STM-2.
4. Connect the other end of the USB cable to a USB port on the computer used to operate Q-pod or STM-2.
5. Install the crystal as instructed by section 4.4 on page 4-10.
6. Launch the appropriate monitor software.
7. Set density at 1.00 g/cm^3.
8. Zero thickness.
9. The display should indicate 0 or ±0.001 kÅ.
   Crystal life should read from 95% to 100%.
   The green indicator on Q-pod should be illuminated.
   All STM-2 error indicators should be extinguished.
10. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should appear on the display. When the moisture evaporates, the thickness indication should return to approximately zero.

If the above conditions are observed, the sensor is in proper working order and may be installed.

2.2 General Guidelines

Figure 2-1 shows the typical installation of an INFICON water-cooled crystal sensor in the vacuum process chamber. Use the illustration and the following guidelines to install the sensor for optimum performance and convenience.

Figure 2-1 Typical installation



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2.2.1 Sensor Installation

The sensor head must be installed such that the face of the crystal is at 90° relative to the source. That is, the crystal must be square to the vapor stream. Two effects may arise if the sensor head is not square to the vapor stream:

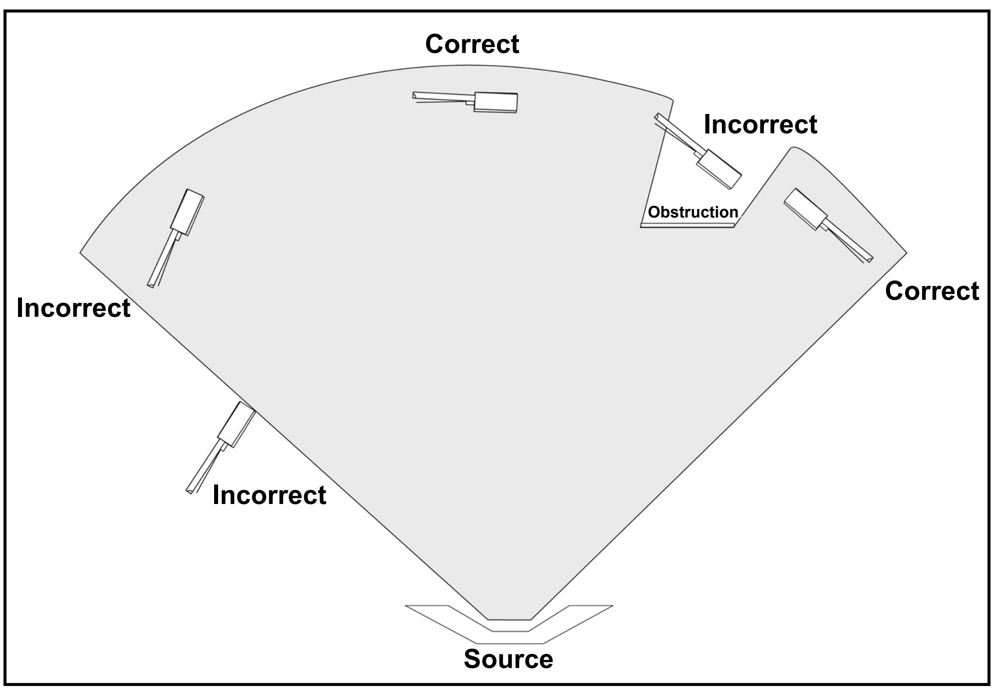
- The deposit is not even across the crystal surface.
  The edge of the crystal that is angled away from the source is farther away from the source and receives somewhat less material, causing the thickness of the deposit to become wedge shaped. This wedge shape in the deposited film tends to reduce the activity of the crystal at its primary resonance.
- The area of the deposit shifts from the center of the crystal.
  This is due to the shadowing effect of the crystal aperture. If the crystal is not square to the evaporant stream, the strength of spurious (non-thickness shear) modes of vibration are enhanced. If the activity of these spurious modes of oscillation become strong enough, they cause short-term perturbation of the fundamental frequency. If they get very strong, the oscillator can look onto the spurious mode of oscillation, causing a mode hop.

The combination of these effects will have a negative effect on crystal life and will increase the probability of mode hops.

Install the sensor as far as possible from the evaporation source (a minimum of 25.4 cm or 10 in.) while keeping the sensor in a position to accumulate thickness at a rate proportional to accumulation on the substrate. Figure 2-2 shows proper and improper methods of installing sensors.

NOTE: For best process reproducibility, rigidly support the sensor so that it cannot move during maintenance and crystal replacement.

Figure 2-2 Sensor installation guidelines



To guard against spattering, use a source shutter to shield the sensor during initial soak periods. If the crystal is hit with only a very small particle of molten material, it may be damaged and stop oscillating. Even in cases when it does not completely stop oscillating, the crystal may immediately become unstable, or shortly after deposition begins, instability may occur.

Plan the installation to ensure there are no obstructions blocking a direct path between the sensor and the source.

Install sensors in such a manner that the center axis of the crystal is aimed directly at the source to be monitored. Verify that the sensor location (with reference to the source) is well within the evaporant stream. Make sure the sensor is square to the vapor stream.

NOTE: In many cases installing multiple sensors to monitor one source will improve thickness accuracy. The rules for multiple sensors are the same as for a single sensor installation, and the locations chosen must be as defined above. Consult the monitor or controller manual for more information regarding the availability of this feature.

A technical description may be found in the 39th Annual Conference Proceedings, Society of Vacuum Coaters, *Reducing Process Variation Through Multiple Point Crystal Sensor Monitoring*, J. Kushneir, C. Gogol, J. Blaise, pp19-23, ISSN 0737-5921 (1996).

2.2.1.1 Sensor Installation Procedure

1. Install all water tube connections, if applicable.
2. Install the sensor and feedthrough assembly into the process system and secure all retaining hardware.
3. Connect the external water tubes from the feedthrough to the water supply system and flow controller. Use detachable couples (Swagelok® or equivalent) for external water tube connections.
4. Apply water pressure and verify the water connections.

Because of geometric factors, variations in surface temperature, and differences in electrical potential, the crystal and substrates often do not receive the same amount of material. Calibration is required to make sure the thickness indication on the instrument accurately represents the thickness on the substrates.

Refer to the instrument operating manual for calibration procedures.

2.3 Bending Tubes

CAUTION

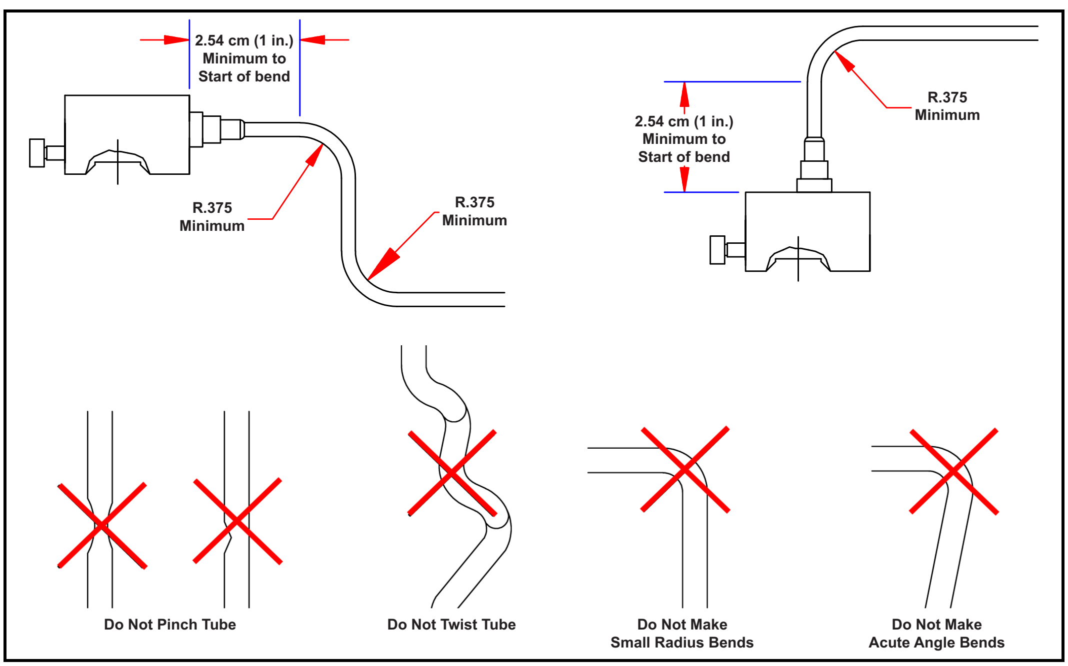
Read this entire section before attempting to bend the tubes. Incorrect tube bending that damages the tubes beyond repair voids the warranty.

If it is necessary to bend the tubes to clear obstacles inside the chamber or to bring the head into a proper mounting location, observe the following precautions:

- Support the tubes where the bends will be placed to avoid a tube being collapsed or pinched. See Figure 2-3.
    - If the cooling tube is collapsed, water flow will be restricted. The sensor will not have sufficient cooling.
    - If the air tube is collapsed, air pressure maybe restricted. The shutter will not operate correctly.
    - An electrical tube that is collapsed or pinched may cause an electrical short.
- Do not make sharp bends. Allow a minimum of 9.5 mm (3/8 in.) bend radius.
- Bends must be farther than 2.54 cm (1 in.) away from the braze joint at the electrical connector. *Bends that are closer will permanently short out the electrical connection or damage the braze joint and void the warranty.*

The 3.175 mm (1/8 in.) tubes are flexible enough to bend, but they are not designed for repeat bending. Plan bends wisely. Before the actual tube bending, verify the bend position again to avoid readjusting. If in doubt, contact INFICON support, refer to section 1.3, How to Contact INFICON, on page 1-3.

Figure 2-3 Correctly bending tubes



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2.4 Installing the Standard and Right Angle Sensors

Standard and Right Angle sensors may be installed in any appropriate location within the vacuum system. Two tapped holes are provided on the back of each single sensor body, and four tapped holes on each dual sensor body, for attaching to the vacuum system.

2.5 Sensor Shutter Function Check

Temporarily connect an air supply to the actuator air tube and test operation for 10 to 15 cycles.

NOTE: The air supply must be 55 PSIG (70 PSIA) to 60 PSIG (75 PSIA) (3.8 to 4.1 bar) (379 to 414 kPa)

When actuated, shutter movement should be smooth, rapid, and complete, and should retract completely from the crystal opening. When deactivated, the shutter should completely cover the crystal opening. Repositioning of the shutter may be required to achieve optimum on/off positioning.

If operation is impaired, lubricate the moving parts with molybdenum disulfide or equivalent.

NOTE: A solenoid valve (PN 750-420-G1) is required with any new shutter installation. See Chapter 3 for more information on the solenoid valve and its installation.

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

2.6 Shutter Operation

The shutter shields the crystal from molten pieces of material during the preconditioning and conditioning phases of a process. A dual sensor head comes standard with one shutter to protect the secondary crystal during the process.

2.6.1 Dual Sensor Head Shutter

INFICON dual sensor heads are designed to provide automatic crystal failure backup or to provide separate crystals for use with two different materials. The two crystals are located side-by-side in a water-cooled housing. Only one crystal is exposed to the evaporation source. The other crystal is covered by the shutter. The normally exposed crystal is the primary (crystal 1) and the covered crystal is the backup (crystal 2). The shutter is moved by pneumatically actuating the bellows assembly. When the pneumatic valve is open (on), the bellows is actuated which moves the crystal shutter over crystal 1 to expose crystal 2.

2.6.2 Single Sensor Head Shutter

For the single sensor head type, a shutter covers the crystal. The shutter does not fully cover the crystal at atmosphere, but once under vacuum, due to the differential pressure, the shutter rests over the crystal. When the pneumatic valve is open (on), the air actuates the bellows, which moves the shutter to expose the crystal.

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Chapter 3
Installation of the Solenoid Valve

3.1 Introduction

The solenoid valve (PN 750-420-G1) and the feedthrough should be installed at the same time. The same solenoid valve is used for both the 2.54 cm (1 in.) and the 7 cm (2-3/4 in.) feedthroughs.

- For Installation with 2.54 cm (1 in.) Bolts Feedthrough, see section 3.2.
- For Installation with 7 cm (2-3/4 in.) Feedthrough, see section 3.3.

NOTE: The air line is 3.175 mm (1/8 in.) as measured on the atmosphere side of the feedthrough. A user supplied connection from the air supply tube on the solenoid valve to the air tube on the Cool Drawer sensor is required.

3.2 Installation with 2.54 cm (1 in.) Bolts Feedthrough

Follow the steps below:

1. Ensure that the O-ring is in place on the bolt.
2. Insert the 2.54 cm (1 in.) bolt such that the hexagonal shaped end of the bolt is on the vacuum side of the chamber.
3. Add the bracket.
4. Add the washer.
5. Add the feedthrough nut.
6. Tighten the feedthrough nut.
7. Connect the 3.175 mm (1/8 in.) air tube from the "A" port of the solenoid valve to the air tube on the feedthrough, see Figure 3-1 on page 3-3.

   NOTE: The air line is 3.175 mm (1/8 in.) as measured on the atmosphere side of the feedthrough. A user supplied connection from the air supply tube on the solenoid valve to the air tube on the Cool Drawer sensor is required.

8. Attach the "P" port of the solenoid valve to a source of air between 55 PSIG (70 PSIA) (3.8 bar) [379 kPa] and 60 PSIG (75 PSIA) (4.1 bar) [414 kPa], see Figure 3-1 on page 3-3.

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

3.3 Installation with 7 cm (2-3/4 in.) Feedthrough

Follow these steps:

1. Align the score line on the valve assembly bracket over the edge of a table or other square edge.
2. Using pliers, grasp the part of the bracket extending over the edge and push down. The assembly will break along the score line.
3. Use a file to smooth any rough edges which may occur along the break.
4. Install the feedthrough.
5. Add the valve bracket (modified) to the desired location using two of the 6.35 mm (1/4 in.) clamp bolts located on the flange.
6. Tighten the flange bolts.
7. Connect the 3.175 mm (1/8 in.) air tube from the "A" port of the solenoid valve to the air tube on the feedthrough, see Figure 3-1.

   NOTE: The air line is 3.175 mm (1/8 in.) as measured on the atmosphere side of the feedthrough. A user supplied connection from the air supply tube on the solenoid valve to the air tube on the Cool Drawer sensor is required.
8. Attach the "P" port of the solenoid valve to a source of air between 55 PSIG (70 PSIA) (3.8 bar) [379 kPa] and 60 PSIG (75 PSIA) (4.1 bar) [414 kPa], see Figure 3-1.

WARNING

Do not exceed 100 PSIG (115 PSIA) (6.9 bar) [689 kPa]. Connection to excessive pressure may result in personal injury or equipment damage.

CAUTION

Maximum temperature for the solenoid valve assembly is 105 °C for bakeout and operation.

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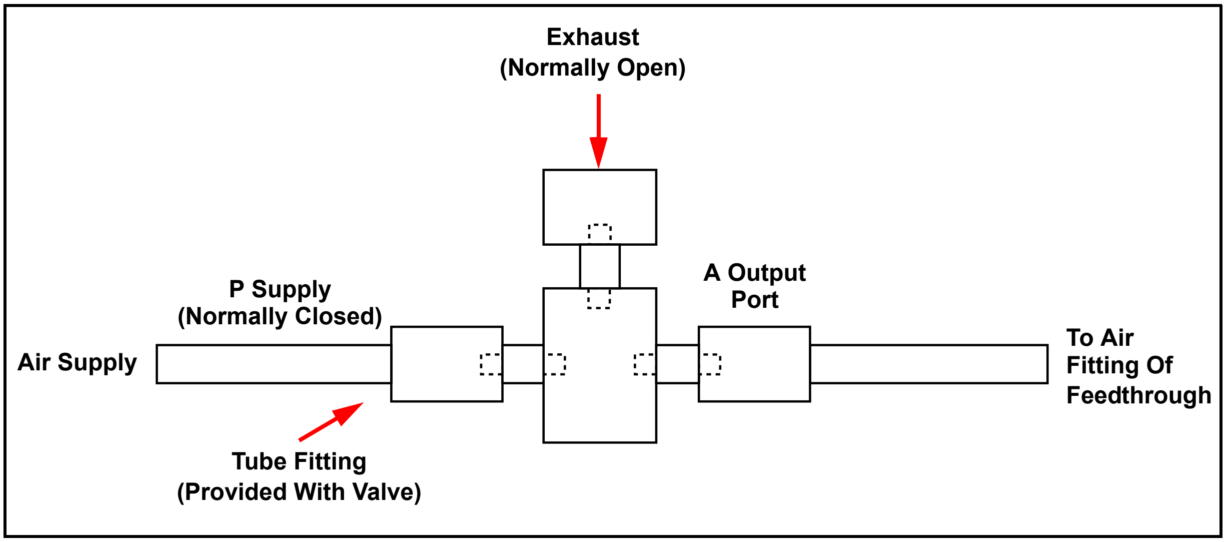
3.4 Electrical and Pneumatic Connections

3.4.1 Electrical

To complete installation of the assembly, make electrical connections to either 24 V (ac) or 24 V (dc). Current required is approximately 70 mA.

Figure 3-1 Miniature pneumatic solenoid tube connections



3.5 Solenoid Valve Drawing

The following Solenoid Valve Outline Drawing provides dimensions and other relevant data necessary for planning equipment configurations.

Figure 3-2 on page 3-4 . . . . Solenoid valve (PN 750-420-G1)

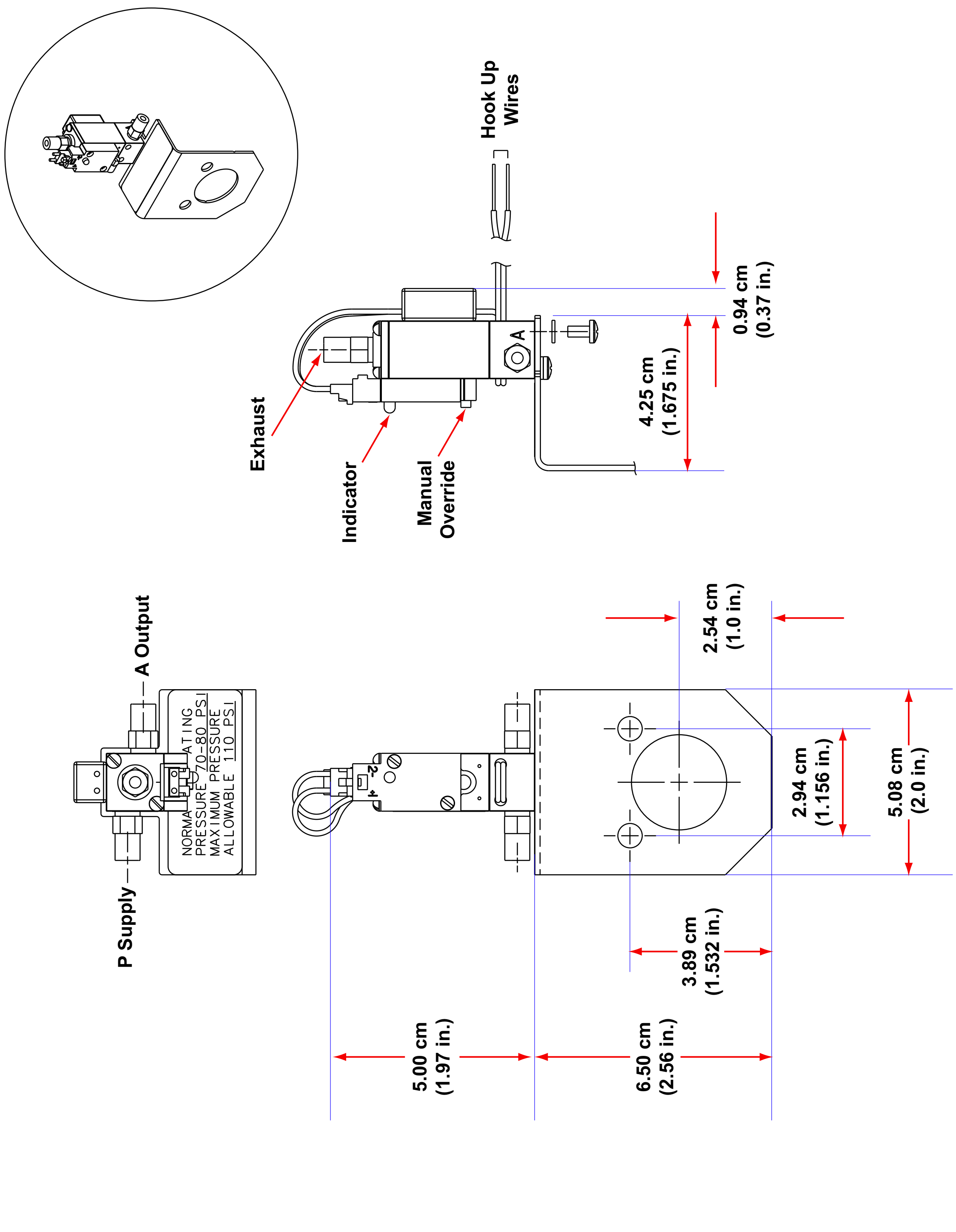


Figure 3-2 Solenoid valve

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Chapter 4
Troubleshooting and Maintenance

4.1 Troubleshooting Guide

If the Cool Drawer sensor fails to function, or appears to have diminished performance, the following Symptom, Cause, Remedy Table in section 4.2 on page 4-5 may be helpful.

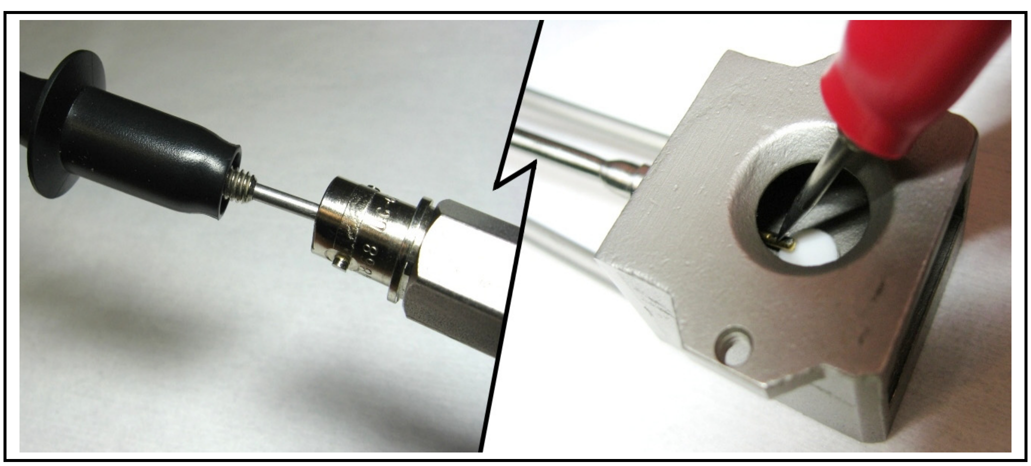
4.1.1 Troubleshooting

A useful tool for diagnosing sensor head problems is the DMM (Digital MultiMeter). Disconnect the short oscillator cable from the feedthrough and measure the resistance from the center pin to ground.

- If the reading is less than 10 megohms the source of the leakage should be found and corrected.
- With the vacuum system open, check for center conductor continuity, a reading of more than 1 Ω from the feedthrough to the transducer contact indicates a problem. Cleaning contacts may be required.

Another useful diagnostic is to continuity-test the sensor head without a crystal. Remove the Cool Drawer from the sensor body. The DMM should measure 1 Ω or less from the center pin of the feedthrough to ground, see Figure 4-1. Reforming the leaf springs may be required if the reading is incorrect.

Figure 4-1 Center conductor continuity



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A very useful tool for rapidly evaluating the cause of a persistent "Crystal Fail" is the test crystal, which is included with each non-modelock oscillator package, this tool utilizes a packaged crystal at 5.5 MHz and a connector that allows the direct connection to BNC cables.

The test crystal provides a known "good" monitor crystal that provides a fast means of isolating sensor problems.

CAUTION

The test crystal is designed as a diagnostic tool, and is not intended for use in vacuum.

4.1.2 Diagnostic Procedures

The following diagnostic procedures employ the test crystal and DMM to analyze a constant Crystal Fail message. The symptom is a Crystal Fail message that is displayed by the deposition controller even after the monitor crystal has been replaced with a new "good" monitor crystal.

4.1.2.1 Measurement System Diagnostic Procedure

1. Remove the 15.2 cm (6 in.) BNC cable from the feedthrough.
2. Connect the test crystal to the BNC cable.
   - If the Crystal Fail message disappears after approximately five seconds, the measurement system is working properly. Reinstall the BNC cable to the feedthrough. Go to section 4.1.2.2.
   - If the Crystal Fail message remains, continue at step 3.
3. Disconnect the BNC cable from the oscillator and from the test crystal.
4. Visually inspect the BNC cable to verify that the center pins are seated properly.
5. Use a DMM to verify the electrical connections on the BNC cable, refer to section 4.1.1.
   - There must be continuity between the center pins.
   - There must be isolation between the center pins and the connector shield.
   - There must be continuity between the connector shields.

   Replace the BNC cable if it is defective and repeat step 2 of this procedure.
6. If the BNC cable is not defective, reconnect it to the oscillator and the test crystal. If the Crystal Fail message remains, contact INFICON (refer to section 1.3 on page 1-3).

4.1.2.2 Feedthrough Diagnostic Procedure

1. Remove the crystal drawer from the sensor head.
2. Disconnect the 15.2 cm (6 in.) BNC cable from the feedthrough.
3. Using a DMM, verify continuity from the BNC center pin on the feedthrough to the center pin on the sensor head, refer to section 4.1.1 on page 4-1. A typical value would be less than 0.2 ohms.
4. Verify isolation of the center pin on the feedthrough from the electrical ground (feedthrough body). A typical value would be in excess of 10 megohms.

If the feedthrough, conduit tube, or BNC connector is defective, replace them, reattach the BNC, and repeat this procedure starting at step 1, otherwise continue at step 5.

5. Verify continuity from the center pin on the BNC connector of the feedthrough to the center pin on the sensor head.
6. Verify isolation from the center pin to electrical ground (feedthrough body).

If the feedthrough system is found to be defective, look for defective contacts at the feedthrough to conduit tube connection. Repair or replace the feedthrough as necessary. Reattach the BNC and repeat this procedure starting at step 1. Otherwise, continue at step 7.

7. Connect the BNC cable to the feedthrough and disconnect it from the Crystal Interface Unit (or oscillator)
8. Verify continuity from the center pin of the sensor head to the un-terminated end of the BNC cable.
9. Verify isolation from the center pin to electrical ground (feedthrough body).

If the feedthrough and BNC cable system is found to be defective, look for defective contacts at the feedthrough to BNC cable connection. Repair or replace the feedthrough as necessary, then reattach the BNC cable to the XIU and repeat this procedure starting at step 2.

4.1.2.3 System Diagnostics Pass But Crystal Fail Message Remains

If the system is operating properly, yet the Crystal Fail message is still displayed, perform the following tasks.

1. On the retainer verify that the center rivet is secure. Repair or replace the retainer as necessary.
2. Inspect the inside of the drawer for a buildup of material. Clean or replace the drawer as necessary.

After verifying the sensor head contacts, the sensor head/conduit tube connection, and the retainer contacts, reassemble the system. If the Crystal Fail message remains, replace the monitor crystal with a good monitor crystal. Verify that the monitor crystal works properly by inserting it into a known good measurement system. If problems continue, contact INFICON (refer to section 1.3 on page 1-3).

4.2 Symptom, Cause, Remedy

Table 4-1 Symptom, Cause, Remedy

SYMPTOM	CAUSE	REMEDY
Large jumps of thickness reading during deposition.	Mode hopping due to damaged or heavily damped crystal.	Replace the crystal.
	Crystal is near the end of its life.	Replace the crystal.
	Scratches or foreign particles on the crystal drawer seating surface.	Clean or polish the crystal seating surface on the crystal drawer. See section 4.5 on page 4-12.
	Uneven coating.	Place the sensor such that the crystal is square to the vapor stream. See section 2.2.1 on page 2-5.
	Particles	Remove source of particles and replace the crystal.
Crystal ceases to oscillate during deposition before it reaches its “normal” life.	Crystal is being hit by small droplets of molten material from the evaporation source.	Use a shutter to shield the sensor during initial period of evaporation; move the sensor farther away.
	Damaged crystal.	Replace the crystal.
	Built-up material on edge of crystal drawer is touching the crystal.	The crystal drawer cannot have a buildup of deposition material. This material may create an unreliable connection to the crystal. Removal of the deposition material is a maintenance necessity. Do not allow seat to get roughened by the removal process.
	Material on crystal drawer is partially masking the full crystal area.	Clean the crystal drawer.
NOTE: Crystal life is highly dependent on process conditions of rate, power radiated from source, location, material, and residual gas composition.		

Table 4-1 Symptom, Cause, Remedy (continued)

SYMPTOM	CAUSE	REMEDY
Crystal does not oscillate or oscillates intermittently (both in vacuum and in air).	Damaged crystal.	Replace the crystal.
	Existence of electrical short or poor electrical contacts.	Check for electrical continuity and short in sensor contacts; check for electrical continuity in feedthroughs, refer to section 4.1.1 on page 4-1.
NOTE: Check the leaf spring contact shape as part of a routine maintenance inspection. Flattened or deformed leaf spring contacts in the retainer are common causes of crystal problems. Lift up each retainer contact spring to a height of approximately 3.3 mm (0.13 in.). See section 4.3.6 on page 4-9.		
Crystal oscillates in vacuum but stops oscillation after open to air.	Crystal is near the end of its life; opening to air causes film oxidation, which increases film stress.	Replace the crystal.
	Excessive moisture accumulation on the crystal.	Turn off cooling water to sensor before opening it to air; flow hot water through the sensor when the chamber is open.
Thermal instability: large changes in thickness reading during source warm-up (usually causes thickness reading to decrease) and after the termination of deposition (usually causes thickness reading to increase).	Crystal not properly seated.	Check and clean the crystal drawer. See Figure 4-5 on page 4-12.
	Excessive heat applied to the crystal.	If heat is due to radiation from the evaporation source, move sensor farther away from source and use Low Thernal Shock crystals for better thermal stability; if the source of crystal heating is due to a secondary electron beam, change to a sputtering sensor.
	No cooling water.	Check cooling water flow rate.
	Heat is from electron flux.	Use sputtering head for non-magnetron sputtering.

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Table 4-1 Symptom, Cause, Remedy (continued)

SYMPTOM	CAUSE	REMEDY
Poor thickness reproducibility.	Erratic source emission characteristics	Move sensor to a different location; check the evaporation source for proper operating conditions; ensure relatively constant pool height and avoid tunneling into the melt.
		Use multiple sensor option if available on controller.
	Material does not adhere to the crystal.	Check the cleanliness of the crystal surface; evaporate an intermediate layer of proper material on the crystal to improve adhesion. Use silver or gold coated crystals, as appropriate.

4.3 General Precautions

4.3.1 Handle the Crystal with Care

Wear clean nylon lab gloves and use clean plastic tweezers when handling the crystal. Handle the crystals only by their edges.

Anything that comes in contact with the crystal surface may leave contamination, which may lead to poor film adhesion. Poor film adhesion will result in high rate noise and premature crystal failure.

CAUTION

Do not use metal tweezers to handle crystals. Metal tweezers may chip the edge of the crystal.

4.3.2 Maintain the Temperature of the Crystal

Periodically measure the water flow rate through the crystal sensor to verify that it meets or exceeds the value specified on page 1-6.

Depending upon the condition of the cooling water used, the addition of an in-line water filtering cartridge may be necessary to prevent flow obstructions.

Many systems use parallel water supply taps that provide high total flows. In a parallel water supply system, an obstruction or closed valve in the pipe that supplies water to the sensor head may not result in a noticeable reduction of total flow. Therefore, monitor the flow leaving the sensor, not the flow entering the sensor.

The crystal requires sufficient water cooling to sustain proper operational and temperature stability. Ideally, a constant heat load is balanced by a constant flow of water at a constant temperature. INFICON quartz crystals are designed to provide the best possible stability under normal operating conditions. However, no crystal can completely eliminate the effects of varying heat loads, such as radiated energy emanating from the evaporant source or from substrate heaters.

4.3.3 Use the Optimum Crystal Type

Silver crystals are recommended for sputtering applications. Certain materials, especially dielectrics, may not adhere strongly to the crystal surface and may cause erratic readings. For many dielectrics, adhesion is improved by using Alloy crystals. Gold is preferred for other applications. Contact INFICON for an appropriate crystal for the specific application, refer to section 1.3 on page 1-3.

4.3.4 Crystal Concerns when Opening the Chamber

Thick deposits of some materials, such as SiO, Si and Ni, will normally peel off the crystal when it is exposed to air, due to changes in film stress caused by gas absorption. When peeling material is observed, replace the crystal.

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4.3.5 Sputtering System Concerns

Cool Drawer sensors are suitable for Magnetron Sputtering and most other sputtering systems where the plasma is controlled and constrained.

For radio frequency (RF) sputtering systems, the INFICON Sputtering sensor (PN 750-618-G1) is recommended. Radio frequency (RF) sputtering systems result in a flux of high-energy electrons which impinge on the sensor head and can cause significant temperature related thickness errors if the change in the temperature of the crystal during deposition is significant.

Standard precautions must be taken when installing the Cool Drawer sensor into a RF sputtering system.

- The sensor must be water-cooled and receive a representative sample of the deposited material (refer to Chapter 2, Sensor Installation).
- The installation of the sensor must not disrupt any electrical fields or otherwise disturb the normal material deposition pattern.

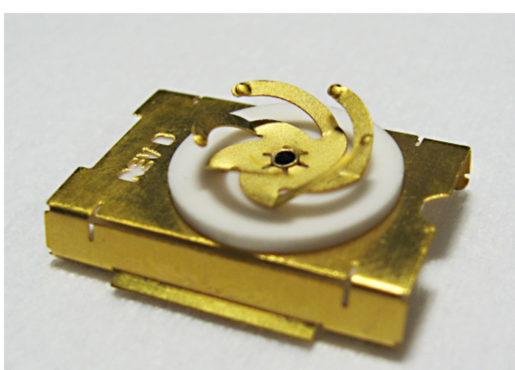
The Cool Drawer sensor must be grounded. Therefore, the Cool Drawer sensor is not suitable for use in bias sputtering where the sensor must be installed at some RF potential above ground.

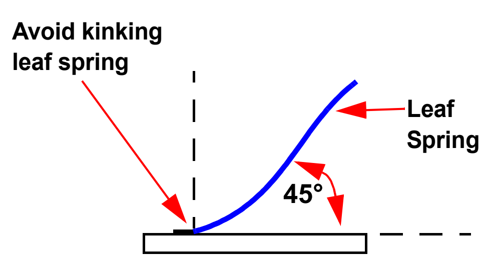
Because the sputtering process is very noisy electrically, it is important to ground the monitor or controller, as well as the sensor, to the base plate or housing of the sputtering chamber. Use a wide ground strap to obtain low impedance at radio frequencies. Normal diameter wires have relatively high impedance at radio frequencies and may allow a significant voltage to develop between the monitor or controller and the system. This voltage is unlikely to cause any damage or shock hazard, but may create an erratic thickness display.

4.3.6 Leaf Spring Maintenance

Leaf spring conditions should be observed as part of the routine maintenance interval. Insufficient bends or deformities in the leaf spring contacts in the sensor body are common causes of crystal problems. See Figure 4-2.

Figure 4-2 Shaping the retainer leaf spring





4.4 Crystal Replacement Instructions

CAUTION

To preserve cleanliness and to maximize crystal performance, all work should be performed in a clean room environment.

1. Using a thumb and index finger, gently squeeze the sides of the retainer at mid-section, then lift the retainer up, away from the drawer, as shown in Figure 4-3.
2. Hold the drawer by the handle and turn it upside down to remove the spent crystal.
3. Prior to installing the new crystal, review section 4.3.1, Handle the Crystal with Care, on page 4-7.
4. Wear clean nylon gloves and grasp the edge of the new crystal with clean plastic tweezers.
5. Orient the new crystal so the patterned electrode is facing up.
6. Insert the new crystal in the drawer and release the crystal. The pattern electrode must be facing up as shown in Figure 4-4.
7. Hold the retainer by its sides. Align its orientation notch with the drawer then gently and evenly push the retainer down until it snaps firmly into the drawer. See Figure 4-4.

CAUTION

Never push down (or pull up) on the contact spring, doing so may permanently damage it.

8. Inspect the entire assembly. The retainer should lay evenly and engage the drawer at all four corners.
9. Reinstall the drawer into the sensor body. Push the drawer straight in making certain that it is completely seated in the sensor body.

Figure 4-3 Removing the crystal

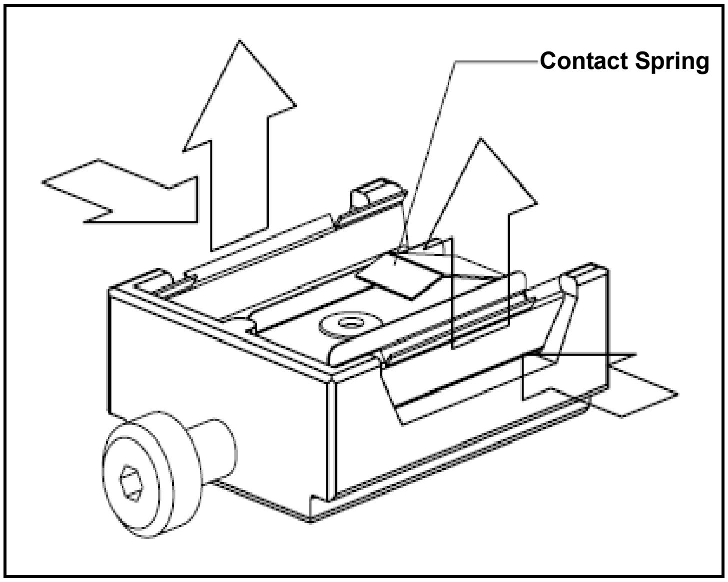
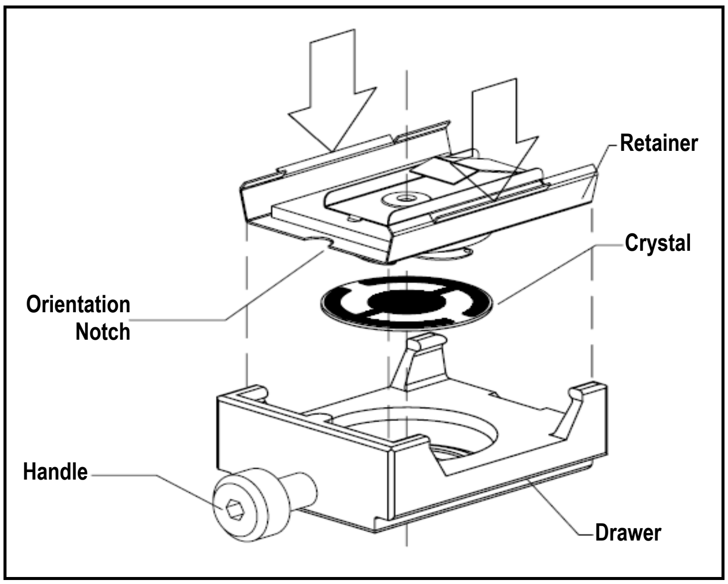


Figure 4-4 Replacing the crystal



CAUTION

Never deposit material on a sensor without the crystal drawer, retainer, and crystal installed.

Material deposited on the exposed sensor body assembly will lead to complete failure of the crystal to oscillate or premature crystal failure. Removing the deposited material will require extensive cleaning and new components.

4.5 Maintenance

4.5.1 Crystal Drawer Maintenance

In dielectric coating applications, the surface where the crystal contacts the crystal drawer may require periodic cleaning. Since most dielectrics are insulators, any buildup on the crystal drawer will eventually cause:

- erratic or poor electrical contact between the crystal and the crystal drawer.
- a reduction in thermal transfer from the crystal to the crystal drawer.

This will result in noisy operation and early crystal failure.

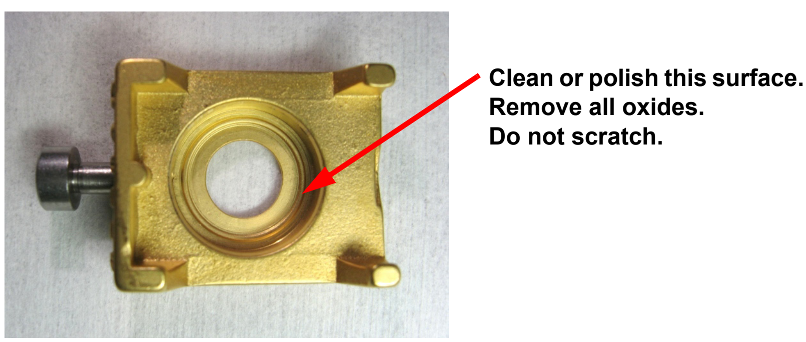
Clean the crystal drawer by ultrasonic cleaning in a soap solution and rinsing. If necessary, gently buff the drawer (see Figure 4-5) with a white Scotch-Brite® pad (1200 to 1500 grit) followed by an ultrasonic bath in soap solution and then by a thorough rinsing in deionized water and drying.

The crystal drawer has a fine finish. This high quality finish is essential to provide good electrical and thermal contact with the crystal.

CAUTION

Applying excessive force during cleaning or using overly abrasive cleaning materials may damage the crystal drawer finish and reduce sensor performance.

Figure 4-5 Crystal Drawer Cleaning



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