OPERATING MANUAL

UHV Bakeable Sensor

PN 074-154N

INFICON

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

UHV Bakeable Sensor

PN 074-154N

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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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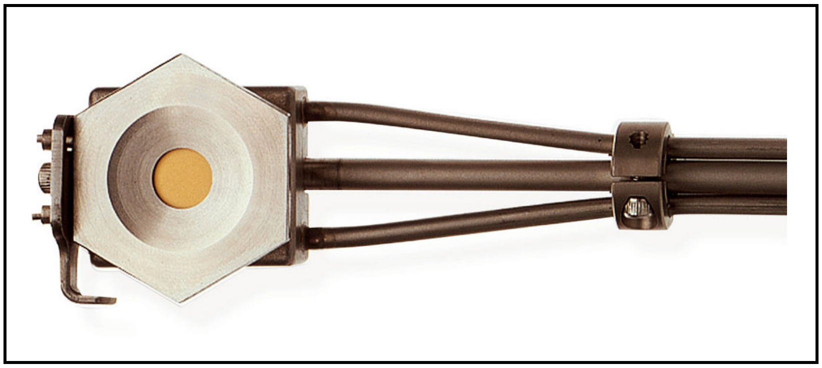
Chapter 1
Introduction and Specifications

1.1 Introduction

The INFICON UHV Bakeable Sensor (see Figure 1-1) is designed to withstand continuous bakeout temperatures up to 450°C (for bakeout only, water flow required for actual deposition monitoring). The front load design allows for easy insertion of the crystal holder in applications lacking sufficient room for side insertion. All UHV Bakeable Sensors are welded to a CF40 (2-3/4 in. ConFlat®) feedthrough. Sensor length must be specified in a sensor length specification form provided by INFICON, which must be completed when ordering the UHV Bakeable Sensor.

Figure 1-1 UHV Bakeable Sensor



The UHV Bakeable Sensor is available in a standard configuration where the water tubes are parallel to the crystal face.

Optionally, sensors can be ordered with a pneumatically driven crystal shutter to protect the crystal during source warm up, when not used during deposition of an alternate material, or to extend crystal life when used with RateWatcher™ or rate sampling.

NOTE: Maximum bakeout temperature for sensors with the optional crystal shutter is reduced to 400°C.

The exposed crystal electrode is fully grounded to effectively eliminate problems due to RF interference.

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 instrument.

WARNING

Failure to heed these messages could result in personal injury.

1.3 How to Contact INFICON

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

- Sales and Customer Service
- Technical Support
- Repair Service

When communicating with INFICON about a UHV Bakeable Sensor, please have the following information readily available:

- The Sales Order or Purchase Order number of the UHV Bakeable Sensor purchase.
- The Lot Identification Code, located on the side surface of the sensor head.
- A description of the problem.
- The exact wording of any error messages that may have been received.
- An explanation of any corrective action that may have already been attempted.

1.3.1 Returning the UHV Bakeable Sensor to INFICON

Do not return any sensor component to INFICON without first speaking with a Customer Support Representative and obtaining a Return Material Authorization (RMA) number. UHV Bakeable Sensors will not be serviced without an RMA number.

Packages delivered to INFICON without an RMA number will be held until the customer is contacted. This will result in delays in servicing the UHV Bakeable Sensor.

Prior to being given an RMA number, a completed Declaration Of Contamination (DoC) form may be required. 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

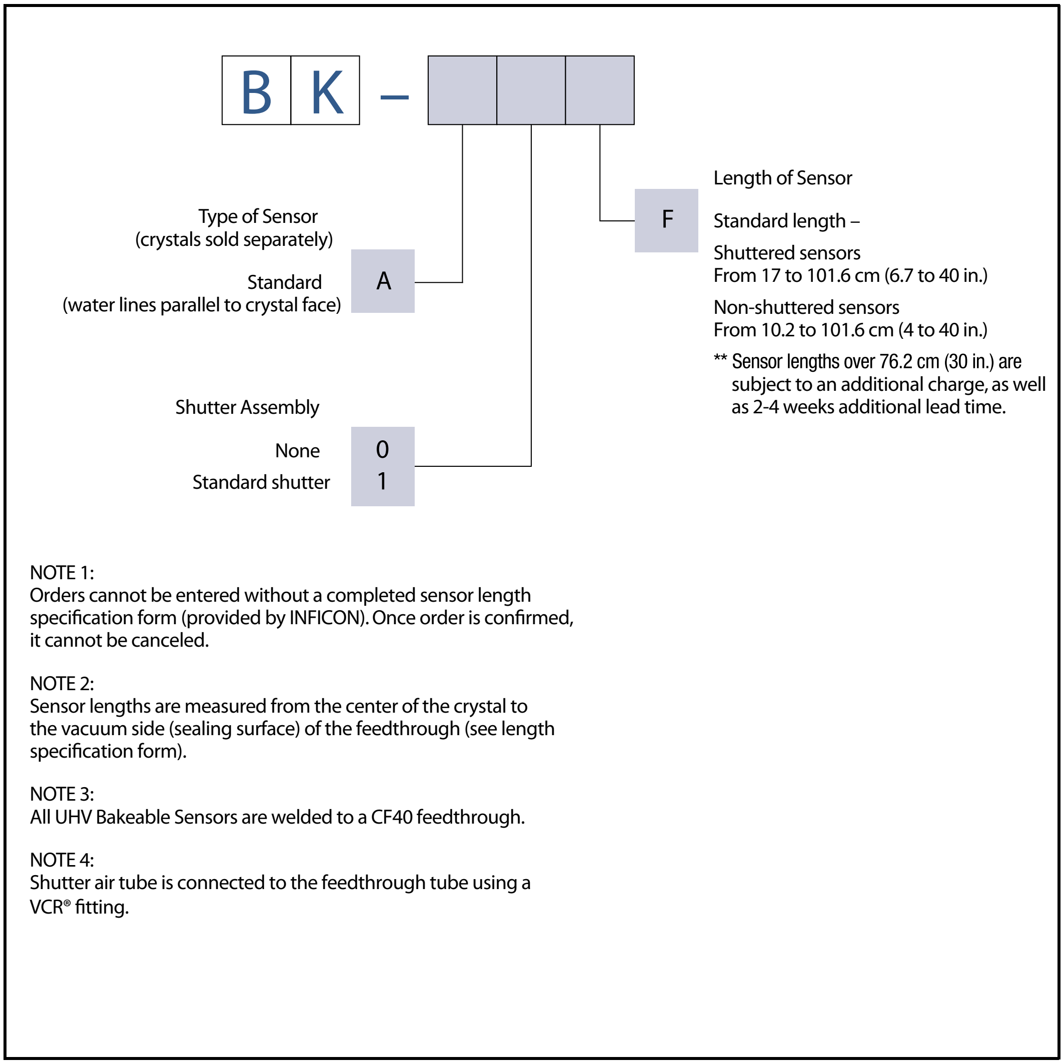
1. If the UHV Bakeable Sensor has not been removed from its packaging, do so now. The sensor and accessories are packaged in a single cardboard carton with a rigid foam insert. Carefully remove the packaged accessories before removing the sensor.
2. Examine the sensor for damage that may have occurred during shipping. It is especially important to note obvious rough handling on the outside of the container. *Immediately report any damage to the carrier and to INFICON.*

   NOTE: Do not discard the packaging material until inventory has been taken and installation is successful.
3. Refer to the invoice and the information contained in section 1.4.1 to take inventory.
4. To install the sensor, see Chapter 2, UHV Bakeable Sensor Installation.
5. For additional information or technical assistance, refer to section 1.3, How to Contact INFICON, on page 1-2.

1.4.1 UHV Bakeable Sensor Configuration Overview and Parts

UHV Bakeable Sensor . . . . BK-AXF (see Figure 1-2)

Figure 1-2 UHV Bakeable Sensor configurations



Thin Film Manuals CD . . . . PN 074-5000-G1

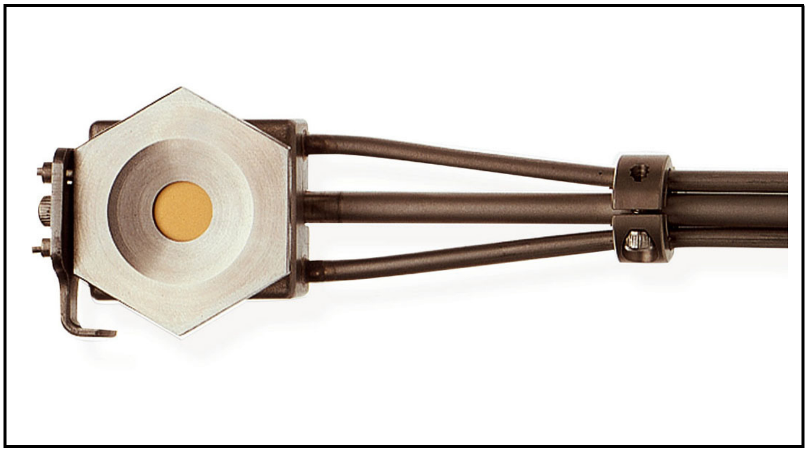
Crystal Snatcher. . . . . PN 008-007

Molybdenum Disulfide in Isopropyl Alcohol . . . . PN 750-191-G1

Graphite in Isopropyl Alcohol
(provided only with shuttered sensors) . . . . PN 009-175

1.5 Specifications for the UHV Bakeable Sensor

Figure 1-3 UHV Bakeable Sensor



1.5.1 UHV Bakeable Sensor without Shutter (PN BK-A0F)

Maximum Temperature. . . . . 450°C continuous bakeout

NOTE: Water flow recommended for deposition.

Sensor Head Size
(maximum envelope) . . . . 34 x 35 x 24 mm
(1.35 x 1.38 x 0.94 in.)

Tubes

Water . . . . 3.2 mm (0.125 in.) OD (vacuum side)
6.4 mm (0.25 in.) OD (atmosphere side)

Coax . . . . 4.8 mm (0.188 in.) OD

Crystal exchange . . . . Front loading, self-contained package,
cam-type locking handle

Mounting. . . . . Four #4-40 tapped holes
(on back of sensor body)
4.57 mm (0.18 in.) thread depth

Crystal
(not included with sensor) . . . . 14 mm (0.550 in.) diameter

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1.5.2 UHV Bakeable Sensor with Shutter (PN BK-A1F)

Maximum Temperature	400°C continuous bakeout **NOTE:** Water flow recommended for deposition.
Sensor Head Size (maximum envelope)	34 x 35 x 31 mm (1.35 x 1.38 x 1.21 in.)
Tubes	
Water	3.2 mm (0.125 in.) OD (vacuum side) 6.4 mm (0.25 in.) OD (atmosphere side)
Air	3.2 mm (0.125 in.) OD (vacuum side) 4.8 mm (0.188 in.) OD (atmosphere side)
Coax	4.8 mm (0.188 in.) OD
Crystal Exchange	Front loading, self-contained package, cam-type locking handle
Mounting	Four #4-40 tapped holes (on back of sensor body) 4.57 mm (0.18 in.) thread depth
Crystal (not included with sensor)	14 mm (0.550 in.) diameter

1.5.3 Materials

Body and Holder	304 stainless steel
Springs	Molybdenum and Inconel® X-750
Tubes	Seamless 304 stainless steel
Other Mechanical Parts	18-8 or 304 stainless steel
Insulators	>99% Al_2O_3
Wire	1) Ni (in vacuum) 2) Ni plated Cu (atmosphere)
Braze	Vacuum process high temperature Ni-Cr alloy

1.5.4 Installation Requirements

Feedthrough . . . . CF40 (2-3/4 in. ConFlat) feedthrough, integral with sensor head

Other . . . . XIU or Oscillator to match specific controller/monitor

BK-A1F only: Solenoid Valve for air, PN 750-420-G1 (see Chapter 3, Solenoid Valve Assembly Installation)

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

NOTE: User should provide means of easily disconnecting the 6.35 mm (1/4 in.) water tubes during bakeout.

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 (BK-A1F only) . . . . 70 psi (gauge) {85 psi (absolute)} (5.8 bar (absolute)) [584 kPa (absolute)] (minimum)

80 psi (gauge) {95 psi (absolute)} (6.5 bar (absolute)) [653 kPa (absolute)] (maximum)

WARNING

Do not exceed 100 psi (gauge) {115 psi (absolute)} (7.9 bar (absolute)) [791 kPa (absolute)].

Connection to excessive pressure may result in personal injury or equipment damage.

1.6 UHV Bakeable Sensor Drawings

The following UHV Bakeable Sensor Outline and Assembly Drawings provide dimensions and other relevant data necessary for planning equipment configurations.

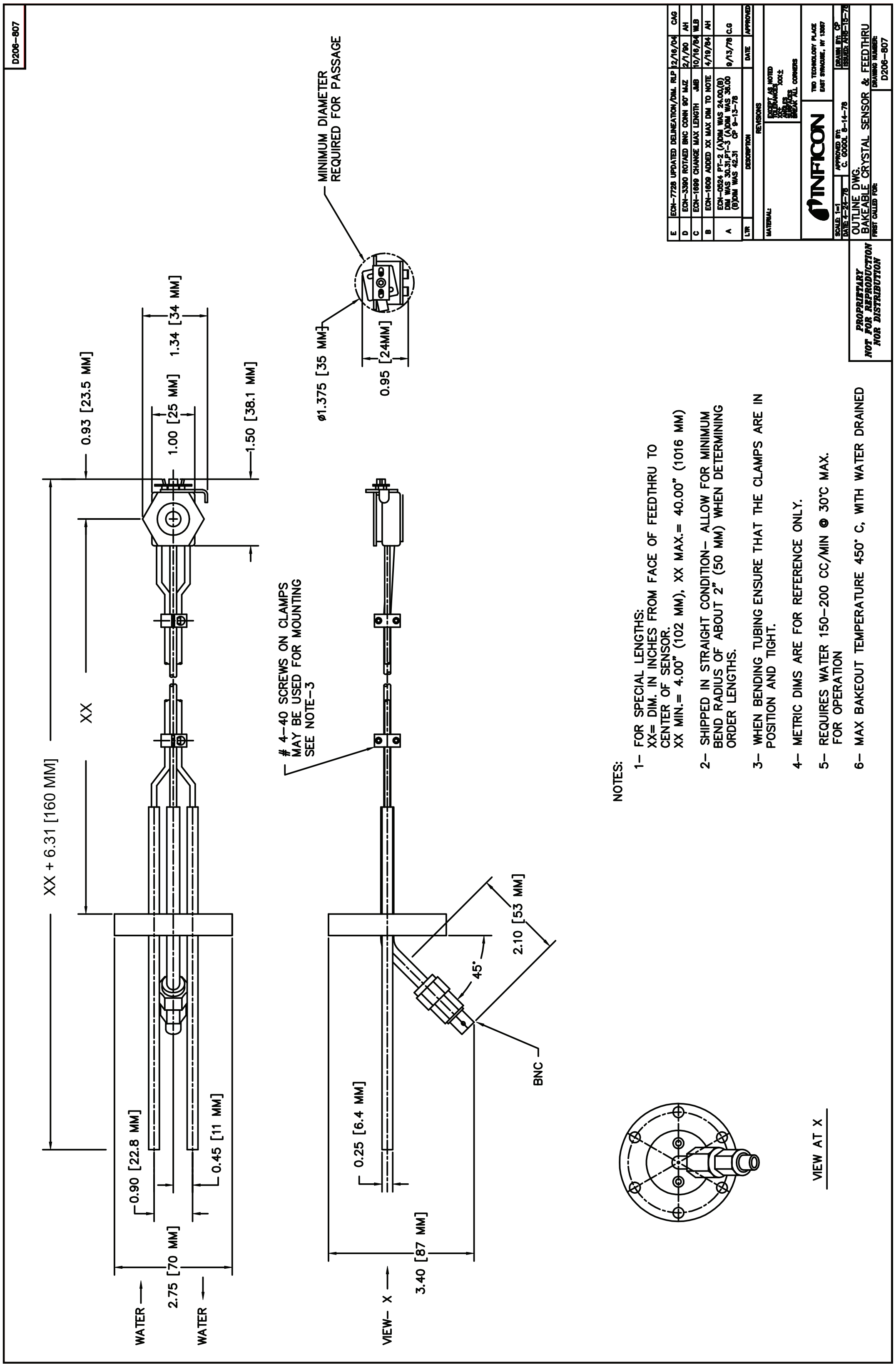

Figure 1-4 UHV Bakeable Sensor and feedthrough outline

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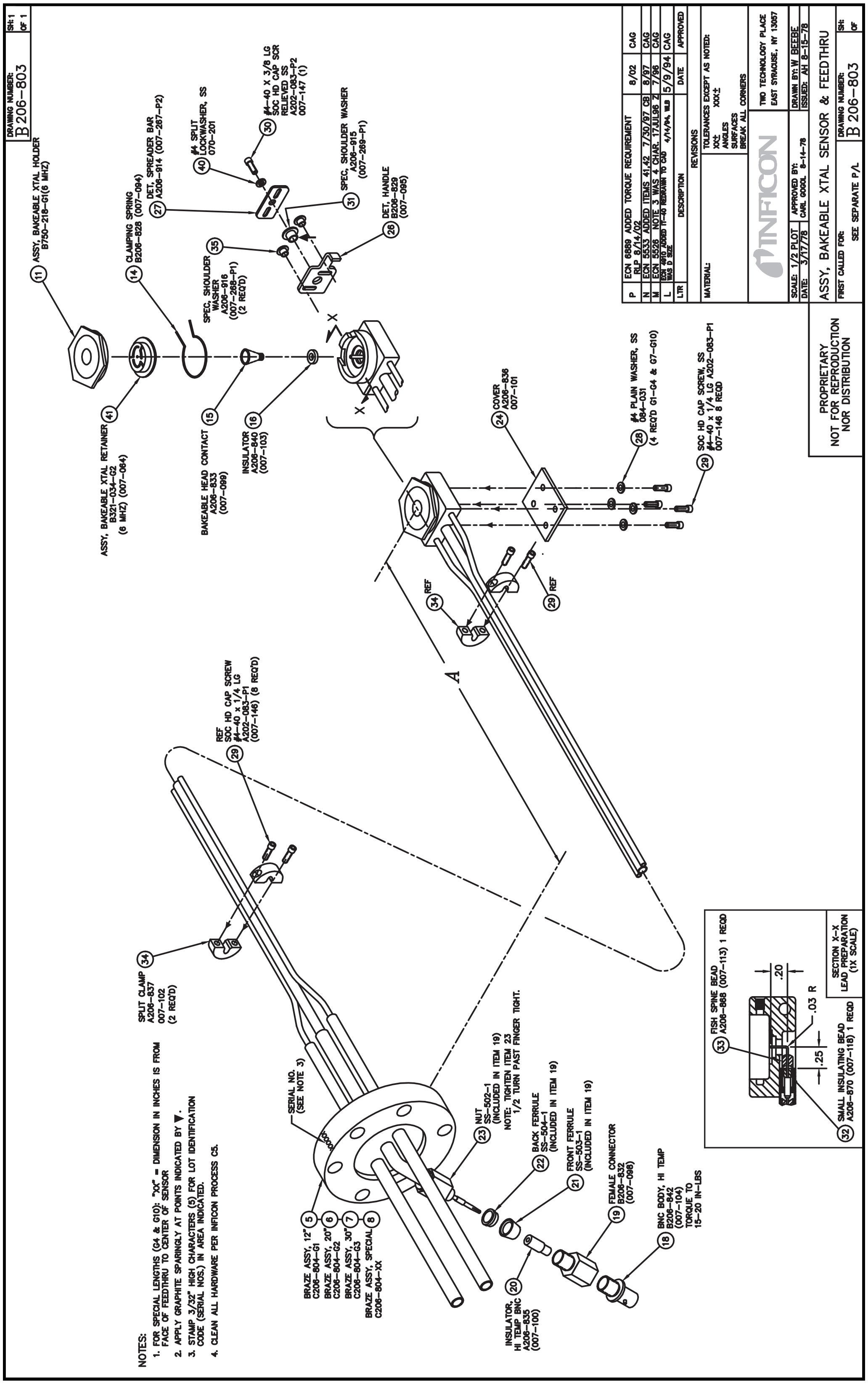

Figure 1-5 UHV Bakeable Sensor and feedthrough assembly

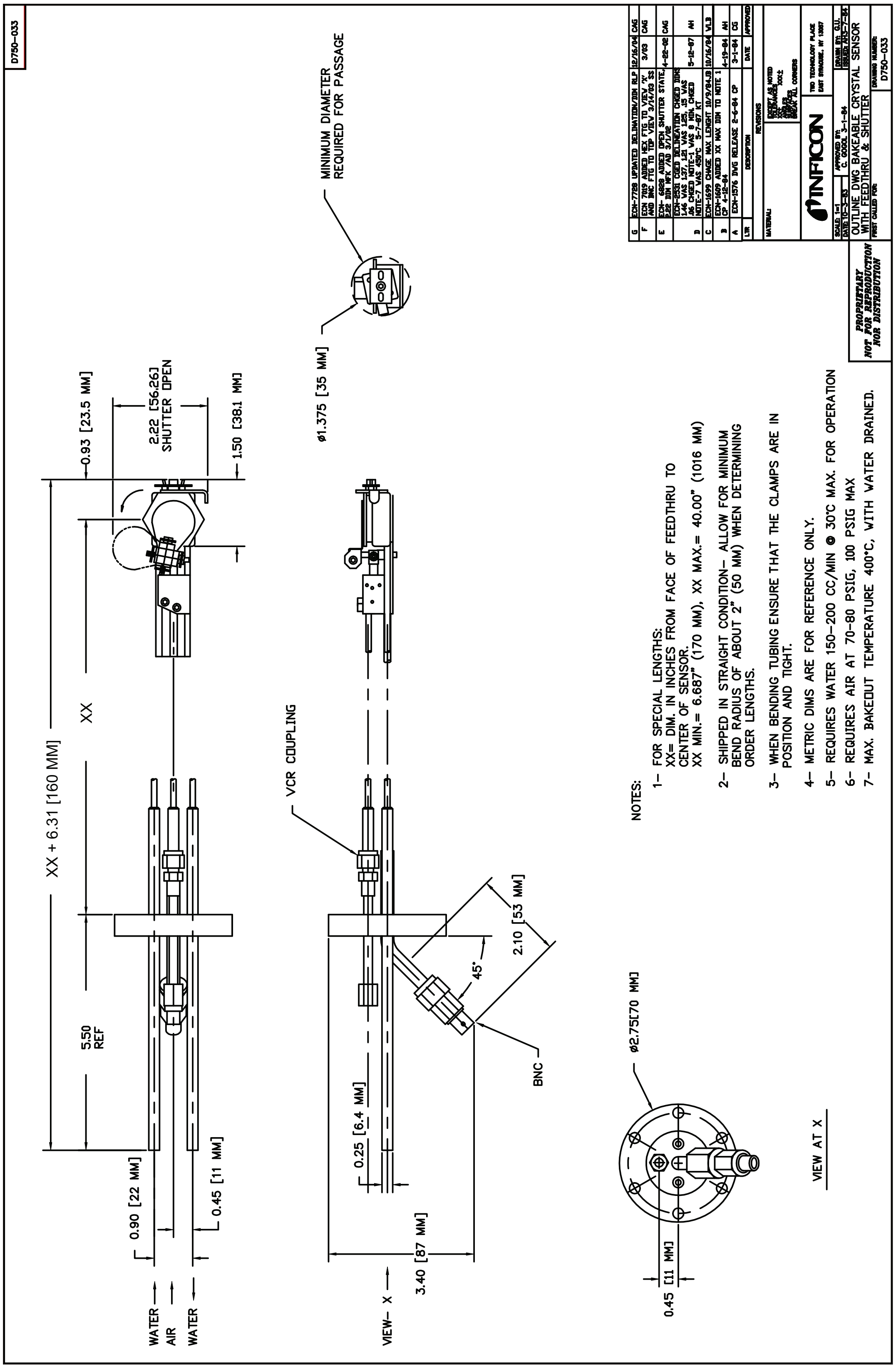

Figure 1-6 Shuttered UHV Bakeable Sensor with feedthrough outline

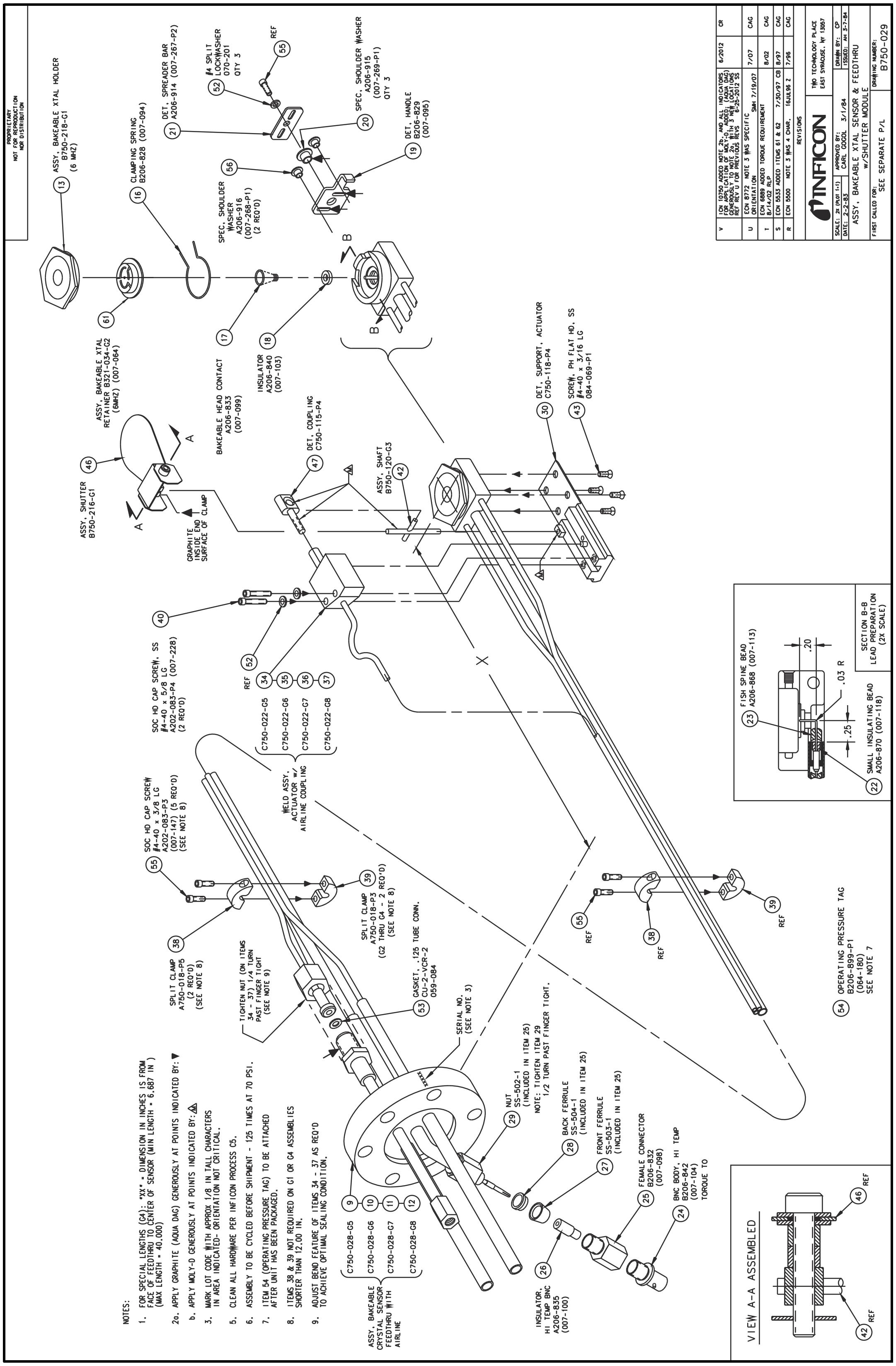

Figure 1-7 Shuttered UHV Bakeable Sensor with feedthrough assembly

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Chapter 2
UHV Bakeable 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.

2.1.1 Sensor Check with 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-PXX) 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 4.2 on page 4-3.
6. Connect power to the controller.
7. Set the power switch to ON.
8. Set density at 1.00 g/cm^3.
9. Zero the thickness. The display should indicate 0 or ± 0.001 kÅ. Crystal life should read from 0 to 5%.
10. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should display. When the moisture evaporates, the thickness indication should return to approximately zero. If these conditions are observed, the sensor is in proper working order and may be installed (see section 2.3 on page 2-7).

2.1.2 Sensor Check with STM-2XM, STM-3, SQM-160, SQC-310, SQM-242, or IQM-233 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 4.2 on page 4-3.
6. Connect power to the controller.
7. Set the power switch to ON.
8. For the SQM-242 card, IQM-233 card, or STM-3, launch the appropriate software.
9. Set density at 1.00 g/cm^3.
10. Zero the thickness. The display should indicate 0 or ± 0.001 kÅ. Crystal life should read from 95 to 100%.
11. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should display. When the moisture evaporates, the thickness indication should return to approximately zero. If these conditions are observed, the sensor is in proper working order and may be installed (see section 2.3 on page 2-7).

2.1.3 Sensor Check with 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 of the Q-pod or STM-2.
3. Connect one end of the USB cable (PN 068-0472) to the mating connector of the Q-pod or STM-2.
4. Connect the other end of the USB cable to a USB port on the computer being used to operate the Q-pod or STM-2.
5. Install the crystal as instructed by section 4.2 on page 4-3.
6. Launch the appropriate monitor software.
7. Set density at 1.00 g/cm^3.
8. Zero the thickness. The display will indicate 0 or ± 0.001 kÅ. Crystal life should read from 95 to 100%. The green indicator on the Q-pod or STM-2 should be illuminated.
9. Breathe heavily on the crystal. A thickness indication of 1.000 to 2.000 kÅ should display. When the moisture evaporates, the thickness indication should return to approximately zero. If these conditions are observed, the sensor is in proper working order and may be installed (see section 2.3 on page 2-7).

2.1.4 Sensor Shutter Check

Temporarily connect an air supply to the actuator air tube fitting on the feedthrough. Use the manual override button on the solenoid valve (see Figure 3-2 on page 3-4), or other means, to activate and deactivate the pneumatic shutter several times.

NOTE: The air supply must be 70 psi (gauge) {85 psi (absolute)} (5.8 bar (absolute) [584 kPa (absolute)] (minimum) to 80 psi (gauge) {95 psi (absolute)} (6.5 bar (absolute)) [653 kPa (absolute)] (maximum).

WARNING

Do not exceed 100 psi (gauge) {115 psi (absolute)} (7.9 bar (absolute)) [791 kPa (absolute)].

Connection to excessive pressure may result in personal injury or equipment damage.

When activated, shutter movement should be smooth, rapid, complete, and the shutter should completely expose the crystal opening. When deactivated, the shutter should completely cover the crystal opening. Repositioning of the shutter may be required to achieve optimum positioning. To adjust the position of the shutter on the shutter shaft, loosen the socket screw on the shutter assembly, rotate the shutter to the desired position, and tighten the socket screw.

NOTE: A Solenoid Valve (PN 750-420-G1) is required for a shuttered sensor installation. See Chapter 3 for more information on the Solenoid Valve and its installation.

2.2 Sensor Installation Guidelines

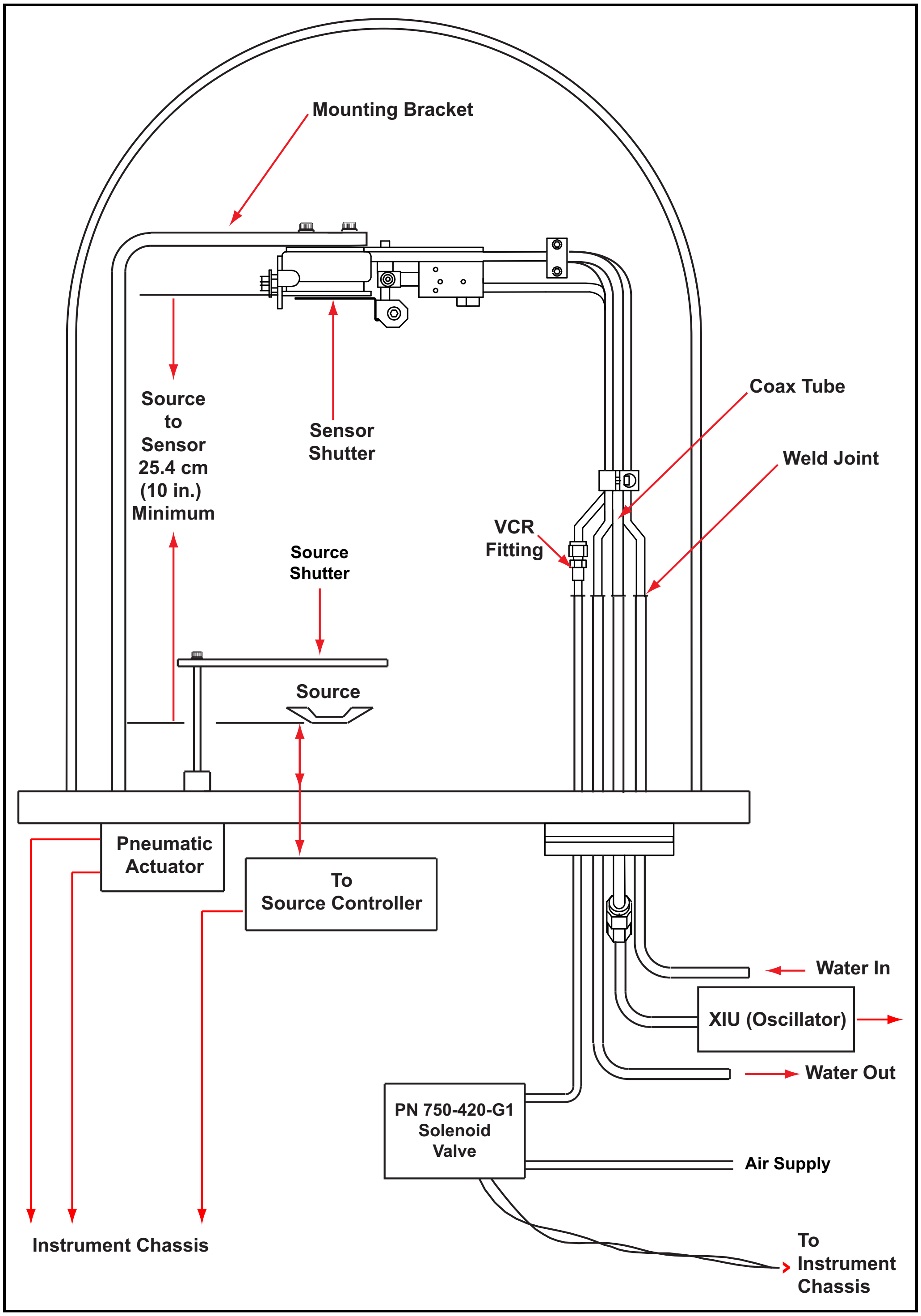
Install the sensor as far as possible from the evaporation source (a minimum of 25.4 cm or 10 in.) while keeping the sensor in a position well within the evaporant stream to accumulate thickness at a rate proportional to accumulation on the substrate. Figure 2-2 on page 2-6 shows proper and improper methods of installing sensors.

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

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

Figure 2-1 shows the typical installation of an INFICON UHV Bakeable Sensor in the vacuum process chamber. Use the illustration and the following guidelines to install sensors for optimum performance and convenience.

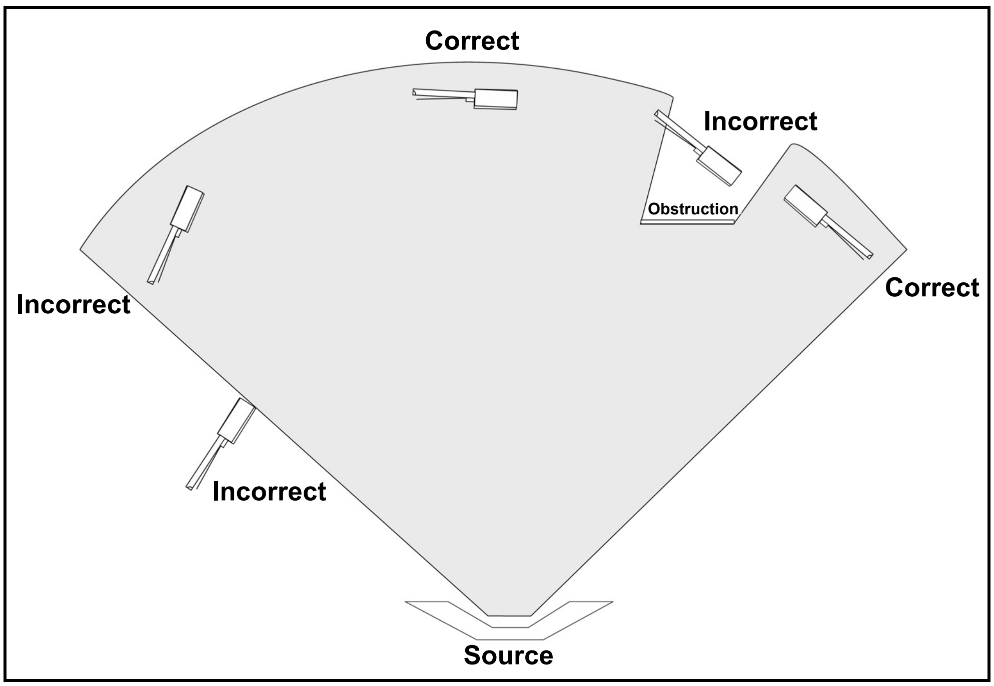
Figure 2-1 Typical UHV Bakeable Sensor installation



The sensor head must be installed such that the face of the crystal is perpendicular to the evaporant stream from the source (see Figure 2-2). Two effects may arise if the sensor head is not perpendicular to the evaporant stream, and the combination of these effects will have a negative effect on crystal life and increase the probability of mode hops:

- The deposit will not be 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 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 lock onto the spurious mode of oscillation, causing a mode hop.

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.

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In many cases installing multiple sensors to monitor one source can 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.

NOTE: 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).

2.3 Sensor Installation Procedure

CAUTION

The UHV Bakeable Sensor 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.

1. A mounting bracket (user provided) is recommended to prevent movement of the sensor head during maintenance or crystal replacement. Assemble the sensor mounting bracket (user provided) on the process system.

   NOTE: Four #4-40 thread holes are provided on the back of the sensor head for attaching the bakeable sensor to the mounting bracket.

2. If the sensor tubing needs to be bent to achieve the desired position of the sensor head, see section 2.3.1, Tube Bending, on page 2-9.
3. Connect the sensor feedthrough to the mating flange on the vacuum chamber.
4. Connect the sensor head to the mounting bracket, using #4-40 screws and the mounting holes provided on the back of the sensor head.

   NOTE: Mounting hole thread depth is 4.57 mm (0.18 in.)

5. 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.
6. Apply water at the specified flow rate (refer to section 1.5.4, Installation Requirements, on page 1-7), and verify that the water connections are tight.

7 If the bakeable sensor has a shutter:

7a Attach air connection to solenoid valve (see Chapter 3) and adjust air pressure to be 70 psi (gauge) {85 psi (absolute)} (5.8 bar (absolute)) [584 kPa (absolute)] (minimum) to 80 psi (gauge) {95 psi (absolute)} (6.5 bar (absolute)) [653 kPa (absolute)] (maximum).

WARNING

Do not exceed 100 psi (gauge) {115 psi (absolute)} (7.9 bar (absolute)) [791 kPa (absolute)].

Connection to excessive pressure may result in personal injury or equipment damage.

7b Activate the solenoid valve (the manual override button may be used), and verify that the sensor shutter moves smoothly and rapidly to completely expose the crystal opening. Deactivate the solenoid valve and verify that the shutter completely covers the crystal opening.

NOTE: If adjustment of the shutter position is needed, loosen the socket screw on the shutter assembly, rotate the shutter to the desired position, and tighten the socket screw.

8 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.

9 Refer to section 1.5 on page 1-5 for other installation requirements, including maximum operating temperatures.

10 See section 2.4 on page 2-10 for recommendations concerning improved cooling for the UHV Bakeable Sensor.

2.3.1 Tube Bending

CAUTION

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

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

- For bakeable sensors with clamps on the tubing, bend the tubing only between the clamps, making sure the clamp screws are tight before bending the tubing.
- For shorter bakeable sensors that do not include clamps, bend the tubing only where the tubes are parallel and in contact with each other.

CAUTION

Do not bend near the sensor head. Stress in this area can crack the ceramic feedthrough and cause loss of vacuum integrity or short the wire providing crystal drive.

- Always use a bending tool or form and support the tubes where the bends will be placed to avoid a tube being collapsed or pinched.
  - If the water tube is collapsed or pinched, water flow will be restricted. The sensor will not have sufficient cooling.
  - If the air tube is collapsed or pinched, air pressure will be restricted. The shutter will not operate correctly.
  - If the coax tube is collapsed or pinched, the wire providing the crystal drive can short.

CAUTION

Do not form the sensor tubes with a bend radius less than 50.8 mm (2.0 in.) from the inside of the bend.

Water, air, and coax tubes are semi-rigid, but flexible enough to bend. They are not designed for repeated 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 1-2).

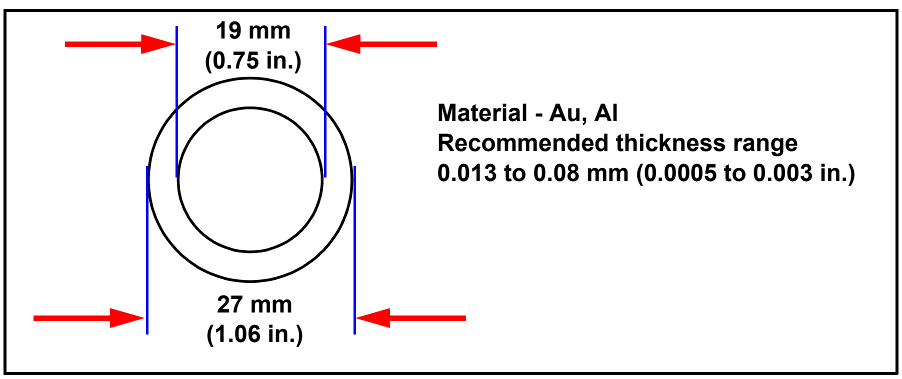
2.4 Providing Improved Cooling for the Sensor

Because of its temperature requirements, the UHV Bakeable Sensor is made primarily of stainless steel. This poses a difficult problem from the design standpoint of thermal transfer. The clamping action of the spring and cam mechanism was found to provide better transfer of heat than other methods, because it allows continuous contact pressure throughout the temperature cycles encountered. However, for some applications where the materials are evaporated at high rate and/or high temperatures, thermal transfer may still be insufficient for ideal operation of the quartz crystal.

To improve the thermal transfer between the crystal holder and the water-cooled body of the UHV Bakeable Sensor, a thin washer can be fabricated of easily deformable metal to insert between the holder and the body. Once fabricated, this washer will last indefinitely. It can provide a 50% improvement in thermal transfer between the two parts by increasing the surface contact between the two non-deformable stainless steel parts.

Both gold and aluminum have been used successfully in this way, but since aluminum foil is nearly perfect in thickness, it is the first choice. (Gold works only slightly better.) Figure 2-3 is a guide to the fabrication of the washer.

Figure 2-3 Guide to fabrication of washer



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Chapter 3
Solenoid Valve Assembly Installation

3.1 Introduction

The solenoid valve assembly (PN 750-420-G1, see Figure 3-2 on page 3-4) and the shuttered UHV Bakeable Sensor assembly should be installed at the same time.

3.2 Installation with the UHV Bakeable Sensor

1. Align the score line on the solenoid valve bracket (see Figure 3-2 on page 3-4) 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 occur along the break.
4. Insert the bakeable sensor through the mating flange on the vacuum chamber.
5. Place the solenoid valve bracket at the desired position on the outside of the feedthrough, with the two holes in the bracket aligned with two of the feedthrough bolt holes.
6. Install and tighten the feedthrough bolts.
7. Remove the quick disconnect air fitting from the exhaust port of the solenoid valve (see Pneumatic Connections, section 3.3) and thread it into the #10-32 fitting adapter on the feedthrough air tube.
8. Connect the 3.175 mm (0.125 in.) air tube from the **A** port of the solenoid valve to the quick disconnect fitting installed in step 7 (see Pneumatic Connections, section 3.3).

9 Attach the **P** port of the solenoid valve to a source of air. The air supply must be 70 psi (gauge) {85 psi (absolute)} (5.8 bar (absolute)) [584 kPa (absolute)] (minimum) to 80 psi (gauge) {95 psi (absolute)} (6.5 bar (absolute)) [653 kPa (absolute)] (maximum) (see Pneumatic Connections, section 3.3.)

WARNING

Do not exceed 100 psi (gauge) {115 psi (absolute)} (7.9 bar (absolute)) [791 kPa (absolute)].

Connection to excessive pressure may result in personal injury or equipment damage.

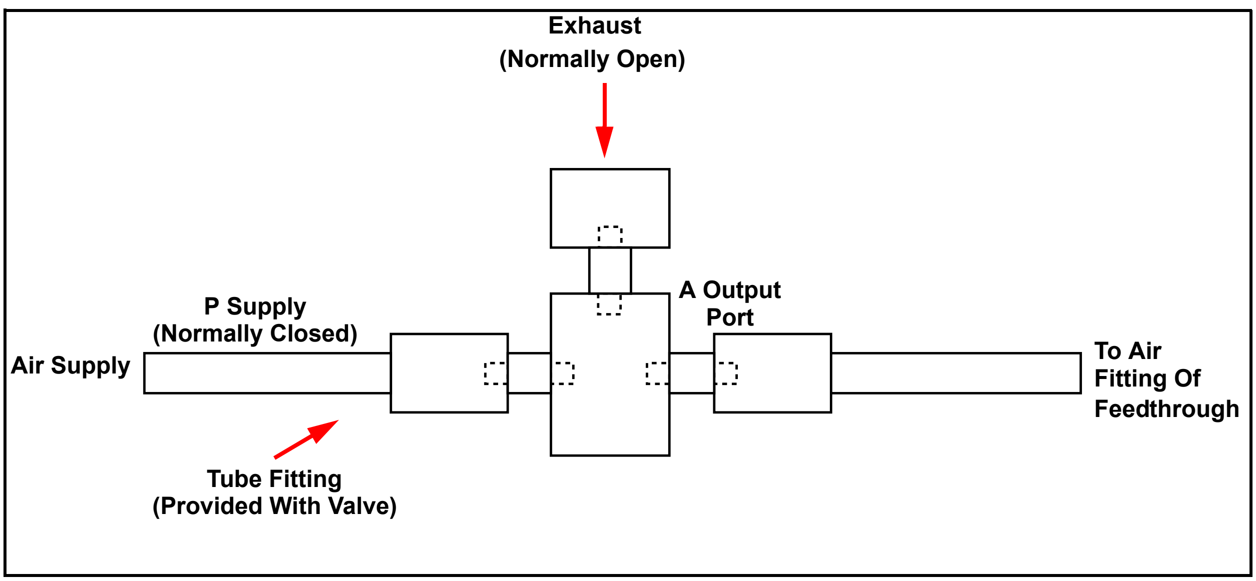
CAUTION

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

10 Make electrical connections to the solenoid valve (see Electrical Connections, section 3.4).

3.3 Pneumatic Connections

Figure 3-1 Pneumatic solenoid valve tube connections



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3.4 Electrical Connections

To complete installation of the assembly, make electrical connections where indicated in Figure 3-2 to either 24 V(ac) or 24 V(dc). Current required is approximately 70 mA.

CAUTION

The maximum applied voltage must not exceed 26 V (ac) or 26 V (dc).

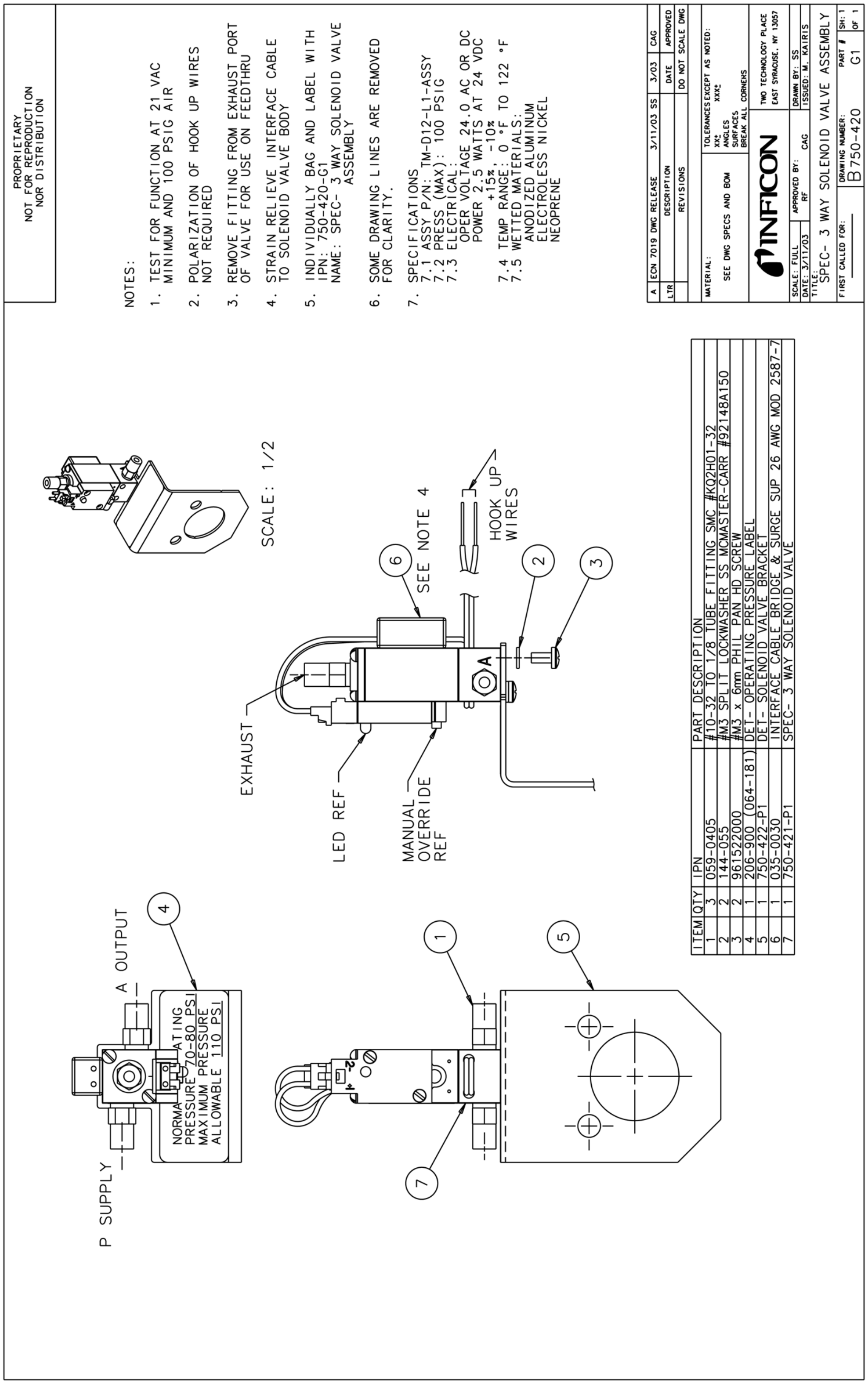

Figure 3-2 Solenoid valve

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Chapter 4
Maintenance and Spare Parts

4.1 General Precautions

CAUTION

Wear clean nylon or talc-free latex lab gloves when handling sensor components. If sensor components become contaminated, clean them thoroughly using a suitable solvent to avoid outgassing under vacuum.

4.1.1 Handle the Crystal with Care

The crystal surfaces are easily contaminated; handle the crystals only by their edges, and always use clean nylon lab gloves when handling crystal holders and retainers and clean plastic tweezers when handling crystals. If using a vacuum pencil to handle crystals, be sure the vacuum pencil tip is clean and not contaminated.

Contamination can 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.

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4.1.2 Use the Optimum Crystal Type

Silver crystals are recommended for sputtering and other applications with sustained high heat loads.

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 crystal material electrode recommendations for a specific evaporant application (refer to section 1.3 on page 1-2).

4.1.3 Maintain the Temperature of the Crystal

Periodically measure the water flow rate leaving the sensor to verify that the flow rate meets or exceeds the flow rate value specified (refer to page 1-7).

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

Many system coaters use parallel water supplies that provide high water flow rates. With a parallel water supply, 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.

No crystal can completely eliminate the effects of varying heat loads. Sources of heat variation include radiated energy emanating from the evaporant source and from substrate heaters.

NOTE: Water cooling temperature near the dew point in the room should be avoided. Condensation can cause early crystal failures.

It is recommended that water cooling temperature be maintained at 5 to 10°C above the dew point in the room during a vent of the system. Water cooling temperature can be lowered to a temperature less than 30°C under vacuum.

4.1.4 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 is observed, replace the crystal.

4.2 Crystal Replacement Instructions

Follow the steps below to replace the crystals.

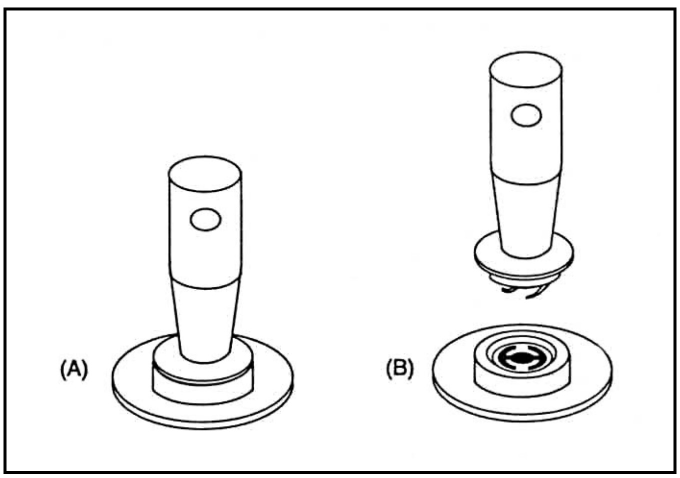
NOTE: Review section 4.1, General Precautions, on page 4-1.

CAUTION

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

1. Remove the crystal holder by releasing the clamping spring handle towards the crystal side of the sensor.
2. Insert the tapered end of the crystal snatcher (PN 008-007) into the ceramic retainer (see Figure 4-1 (**A**)) and apply a small amount of pressure. This locks the retainer to the snatcher and allows the retainer to be pulled straight out (see Figure 4-1 (**B**)).

Figure 4-1 Using the crystal snatcher



3. Invert the crystal holder and the crystal will drop out.
4. Prior to installing the new crystal, review section 4.1.1, Handle the Crystal with Care, on page 4-1.
5. Grasp the edge of the new crystal with clean plastic tweezers. Orient the crystal so the patterned electrode is facing up. Gently insert the edge of the crystal beneath one of the wire segments that protrude into the crystal cavity. Release the crystal.

6 Replace the ceramic retainer. Initially orient it at an angle to displace the spring wire segments in the crystal holder.

CAUTION

***Do not use excessive force* when handling the Ceramic Retainer Assembly since breakage may occur. Always use the crystal snatcher.**

***To prevent scratching* the crystal electrode, do not rotate the ceramic retainer after installation.**

7 Release the crystal snatcher with a slight side-to-side rocking motion. Using the backside of the crystal snatcher, push on the ceramic retainer to ensure it is completely seated.

8 Reinstall the holder in the sensor body. Push the holder straight in making certain that it is completely seated in the senor body, then latch the clamping spring handle.

CAUTION

Never deposit material on a sensor unless the crystal holder and crystal are installed. Material deposited on the exposed sensor body assembly will cause either complete failure to oscillate or lead to premature crystal failure. Removing the deposited material requires extensive rework and new components.

4.3 UHV Bakeable Sensor Maintenance

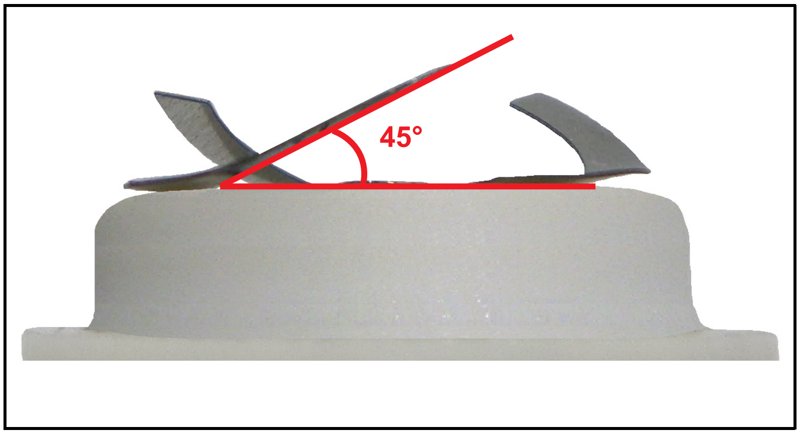
4.3.1 Adjusting the Leaf Spring

UHV Bakeable Sensors have one leaf spring with three prongs located on the ceramic retainer that provides an electrical connection to the crystal electrode.

Examine the prongs on the leaf spring positioned on the ceramic retainer. If they are significantly lower than shown by Figure 4-2, they should be adjusted to an angle of approximately 45 degrees.

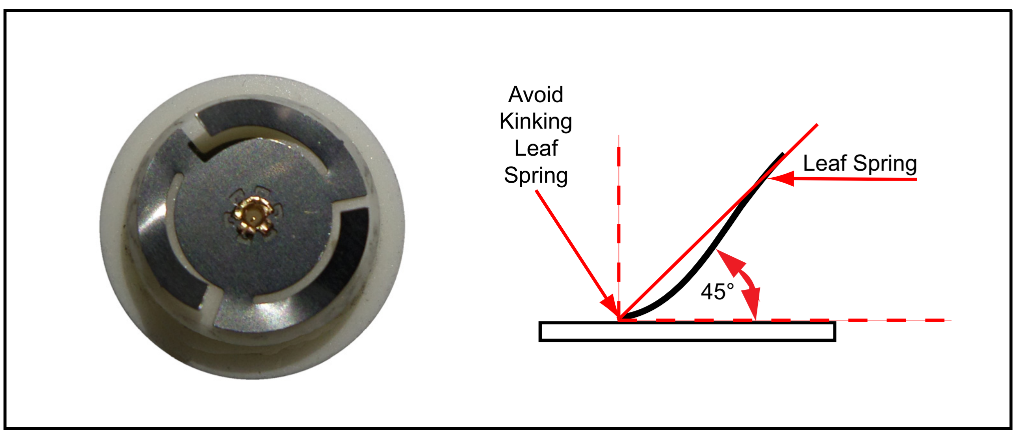
NOTE: A leaf spring adjusted to 45 degrees will flatten slightly after being inserted into and extracted from the crystal holder.

Figure 4-2 Ceramic retainer



To adjust the prongs on the leaf spring positioned on the ceramic retainer, touch the end of the prong with a gloved finger, or grip the prong with Teflon tweezers, and gently lift it upward. Be careful not to kink the prongs. An ideal bend has a smooth, sweeping shape (see Figure 4-3).

Figure 4-3 Leaf spring shape



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4.3.2 Cleaning the Crystal Holder

In dielectric coating applications, the crystal seating surface of the crystal holder may require periodic cleaning. Since most dielectrics are insulators, any material buildup on this surface from an evaporation process can cause a poor electrical contact between the crystal and the crystal holder. Material buildup will also cause a reduction in thermal transfer from the crystal to the sensor body. A poor electrical contact or poor thermal transfer will result in noisy operation and early crystal failure.

Cleaning may be accomplished by following three steps:

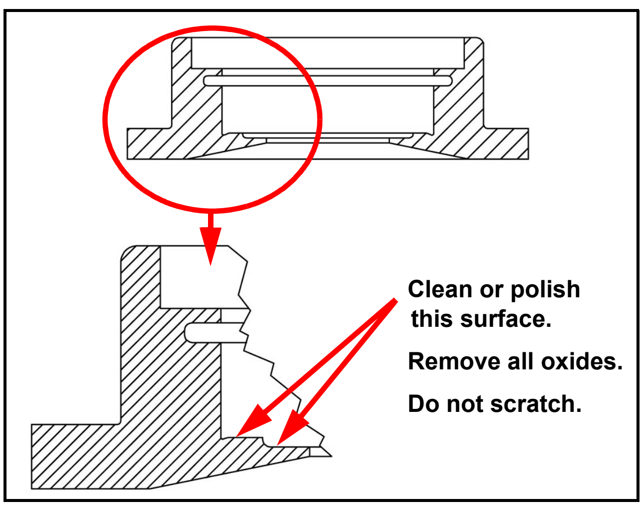
1. Gently buffing the crystal seating surface in the crystal holder with a white, #7445 Scotch-Brite™ cleaning pad (ee Figure 4-4).
2. Washing the crystal seating surface in the crystal holder in an ultrasonic bath in soap solution.
3. Thorough rinsing of the crystal seating surface in the crystal holder with deionized water and drying, or by ultrasonic cleaning and deionized water rinsing only.

NOTE: The crystal holder seating surface is machined to a very fine finish (16 micro inches rms). 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 this finish and reduce sensor performance.

Figure 4-4 Crystal holder cleaning



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4.3.3 Adjusting the Crystal Holder Retainer Spring

Occasionally, the ceramic retainer may not be secured in the crystal holder. To alter the retainer retention force, use the following procedure.

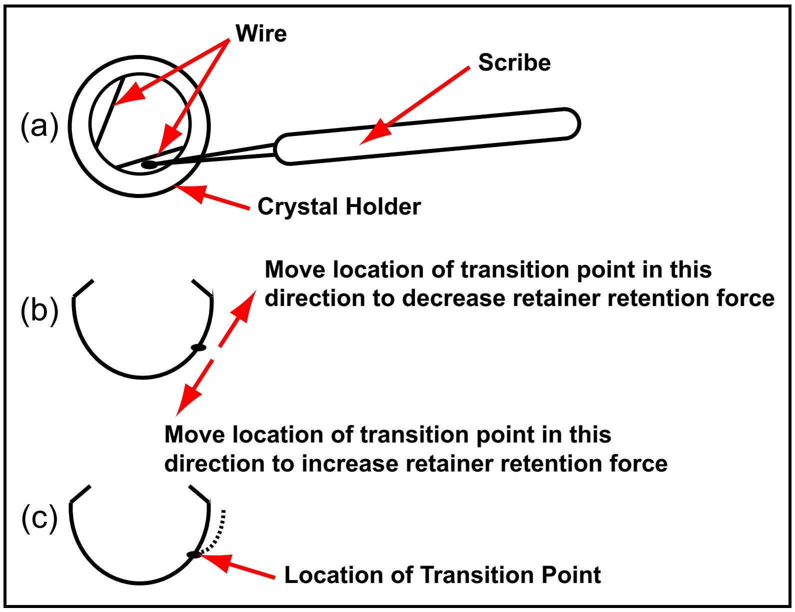
Tools required

- Scribe or other pointed tool
- Needle nose pliers (two required)

Procedure

1. Position the crystal holder with the crystal aperture oriented downward.
2. Insert the point of the scribe between the inside edge of the crystal holder cavity and one of the two wire segments that protrude into the crystal cavity (see Figure 4-5 (**a**)).

Figure 4-5 Location of the transition point



3. Using the scribe, gently remove the spring from its groove in the crystal holder cavity.
4. Refer to Figure 4-5 (**b**) to determine the direction in which the ‘transition point’ must be relocated, to attain the desired retention forces. Moving this transition point approximately 1.59 mm (1/16 in.) is generally sufficient.
5. Grasp the spring, with the pliers, just below the transition point. Use the second set of pliers to bend the spring as illustrated by the dashed line in Figure 4-5 (**c**) to remove the existing transition point.
6. Use both pliers to form a new transition point according to Figure 4-5 (**b**), thus returning the spring to a shape similar to the solid line delineation of Figure 4-5 (**c**).

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7 Reinstall the spring into the groove provided in the crystal cavity.

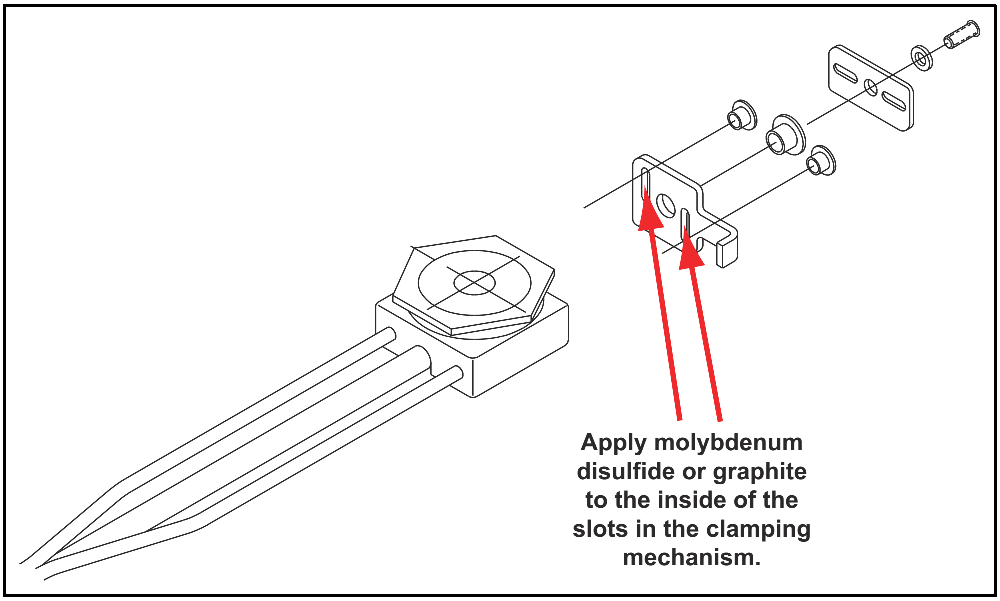
8 Determine if the retention force is acceptable and that the wire does not impede crystal insertion. If needed, repeat the adjustment procedure.

4.3.4 Lubricating the Clamping Mechanism

If operation is impaired, lubricate moving parts with molybdenum disulfide (PN 750-191-G1), provided with each shuttered sensor, or graphite (PN 009-175), if appropriate for the process.

The clamping mechanism may need to be lubricated on both shuttered and non-shuttered UHV Bakeable Sensors (see Figure 4-6).

Figure 4-6 Lubricating the clamping mechanism

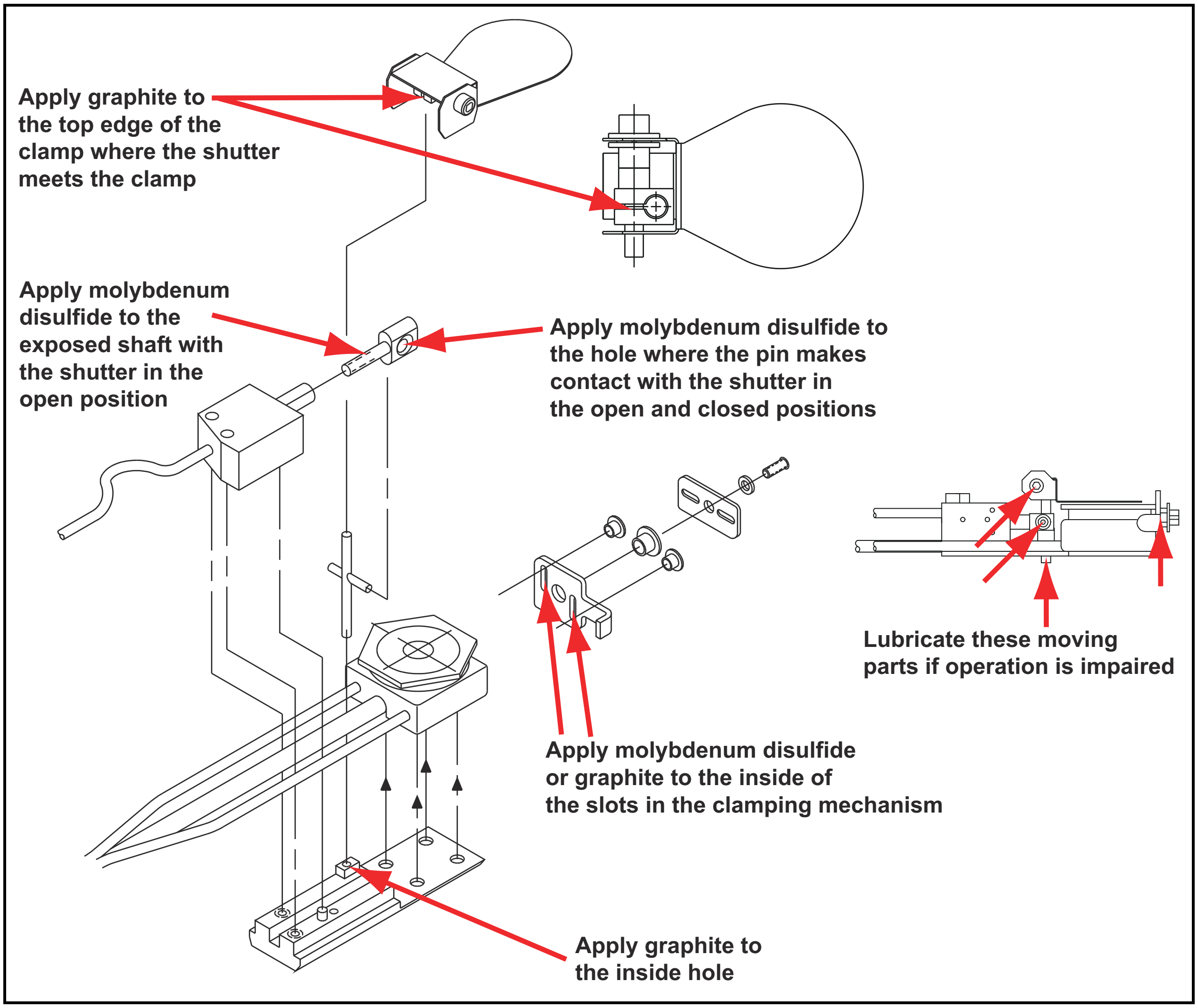


4.3.5 Lubricating the Shutter Module

The shutter module should be lubricated approximately every 2000 strokes at areas specified as shown in Figure 4-7. Failure to lubricate the shutter module may significantly reduce life of operation or cause assembly to become inoperative.

For lubrication, use molybdenum disulfide (PN 750-191-G1), provided with each shuttered sensor, or use graphite (PN 009-175), if appropriate for the process.

Figure 4-7 Lubrication of shuttered UHV Bakeable Sensor



4.4 Replacement Parts and Accessories

Ceramic Retainer . . . . PN 007-064

Crystal Holder. . . . . PN 750-218-G1

Shutter . . . . PN 750-216-G1

Crystal Snatcher. . . . . PN 008-007

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Chapter 5
Troubleshooting

5.1 Troubleshooting Tools

If the UHV Bakeable Sensor fails to function, or appears to have diminished performance, diagnose the sensor using one or more of the following:

- Symptom, Cause, Remedy chart (see section 5.1.1)
- Diagnostic Tools (see section 5.1.2 on page 5-4)
- Digital Multimeter (see section 5.1.3 on page 5-5)

5.1.1 Symptom, Cause, Remedy

The Symptom, Cause, Remedy chart can help identify the causes of, and solutions to, sensor problems and related issues (see Table 5-1).

Table 5-1 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.	
	Scratches or foreign particles on the crystal holder seating surface.	Clean or polish the crystal seating surface of the crystal holder (refer to section 4.3.2 on page 4-6).
	Uneven coating.	Mount the sensor with the crystal face perpendicular to the evaporant stream (refer to section 2.2 on page 2-4).
	Particles on the crystal.	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 from the source.

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Table 5-1 Symptom, Cause, Remedy (continued)

SYMPTOM	CAUSE	REMEDY
Crystal ceases to oscillate during deposition before it reaches its “normal” life.	Damaged crystal.	Replace the crystal.
	Deposition material on crystal holder opening is touching the crystal.	Remove material buildup from the crystal holder opening, being careful not to scratch the crystal seating surface (refer to section 4.3.2 on page 4-6).
	Deposition material on crystal holder opening is partially masking the crystal.	
Short crystal life	Crystal life is highly dependent on process conditions of rate, power radiated from source, location, material, and residual gas composition.	
Crystal does not oscillate or oscillates intermittently (both in vacuum and in air).	Damaged crystal.	Replace the crystal.
	Sensor or feedthrough has electrical short or open, or poor electrical connections.	Check electrical continuity and isolation of sensor and feedthrough (see section 5.1.3 on page 5-5).
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 venting vacuum chamber. Flow hot water through the sensor when the vacuum 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 is not properly seated, causing poor thermal transfer from crystal to crystal holder.	Check and clean the crystal seating surface of the crystal holder (refer to section 4.3.2 on page 4-6).
	Thermal transfer from crystal holder to sensor body is insufficient for the application.	Install a thin metal washer between crystal holder and sensor body to improve thermal transfer (refer to section 2.4 on page 2-10).

Table 5-1 Symptom, Cause, Remedy (continued)

SYMPTOM	CAUSE	REMEDY
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).	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 Thermal Shock crystals (PN SPC-1157-G10) for better thermal stability. If the source of crystal heating is due to a secondary electron beam, use a sputtering sensor.
	No cooling water. Water flow rate is low. Water temperature too high.	Check cooling water flow rate.
	Heat induced from electron flux.	Use sputtering head for non-magnetron sputtering.
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. Use gold or silver or alloy crystals, as appropriate. Evaporate an intermediate layer of proper material on the crystal to improve adhesion.

5.1.2 Diagnostic Tools

The following diagnostic tools can be used to determine if a crystal fail condition is due to the UHV Bakeable Sensor or the instrument the sensor is used with:

- PN 782-902-023 oscillator with 5.5 MHz test crystal (see section 5.1.2.1).
- OSC-100 oscillator test function (see section 5.1.2.2).
- PN 760-601-G2 Crystal Sensor Emulator (see section 5.1.2.3).
- XIU test function (see section 5.1.2.4).

5.1.2.1 PN 782-902-023 Oscillator with 5.5 MHz Test Crystal

1. Disconnect the short BNC cable from the BNC connector on the bakeable sensor feedthrough.
2. Connect the 5.5 MHz test crystal (included with oscillator) to the short BNC cable connected to the oscillator.
   - If the crystal fail disappears within 5 seconds, the bakeable sensor is the cause of the crystal fail.
   - If the crystal fail is still present after 5 seconds, the controller or monitor, the oscillator, or a cable is the cause of the crystal fail. Refer to the controller or monitor operating manual.

5.1.2.2 OSC-100 Test Function

1. Disconnect the short BNC cable from the BNC connector on the bakeable sensor feedthrough.
2. Depress the test button on the OSC-100 oscillator.
   - If the crystal fail disappears within 5 seconds with the button depressed, the bakeable sensor or the short BNC cable is the cause of the crystal fail.
   - If the crystal fail is still present after 5 seconds with the button depressed, the controller or monitor, the oscillator, or a cable is the cause of the crystal fail. Refer to the controller or monitor operating manual.

5.1.2.3 PN 761-601-G2 Crystal Sensor Emulator

1. Disconnect the short BNC cable from the BNC connector on the bakeable sensor feedthrough.
2. Connect the Crystal Sensor Emulator to the short BNC cable connected to the XIU or oscillator.
   - If the crystal fail disappears within 5 seconds, the bakeable sensor is the cause of the crystal fail.
   - If the crystal fail is still present after 5 seconds, the controller or monitor, the oscillator or XIU, or a cable is the cause of the crystal fail. Refer to the controller or monitor operating manual.

5.1.2.4 XIU Test Function

The XIU Test function is a feature of IC/5, Cygnus, IC6, Cygnus 2, and XTC/3 controllers. Refer to the controller operating manual for instructions on using the XIU test function.

5.1.3 Digital Multimeter

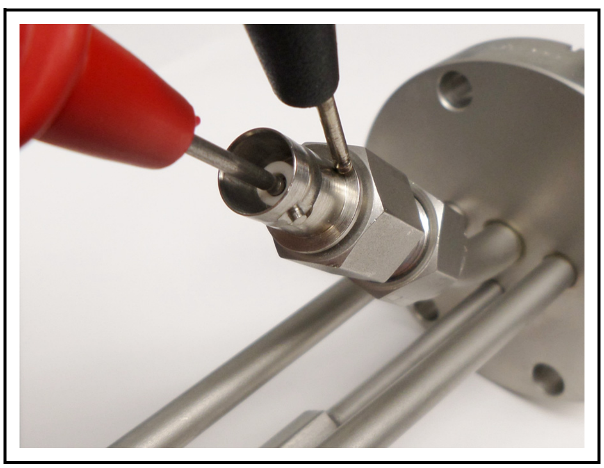
A useful tool for diagnosing sensor problems is the Digital Multimeter (DMM).

To isolate the cause of a sensor problem, perform electrical isolation and continuity checks, starting with the Electrical Isolation Check (section 5.1.3.1).

5.1.3.1 Electrical Isolation Check

1. Remove the crystal holder from the bakeable sensor.
2. Disconnect the BNC cable from the bakeable sensor feedthrough.
3. Select the DMM ohmmeter function and a high megohm (MΩ) resistance scale.
4. At the BNC connector on the feedthrough, measure the resistance between the center contact and shield, as shown by Figure 5-1.
    - If resistance is more than 10 MΩ, electrical isolation is good. Go to section 5.1.3.2, Electrical Continuity Check, on page 5-6.
    - If resistance is less than 10 MΩ, contact INFICON (refer to section 1.3 on page 1-2).

Figure 5-1 BNC connector resistance



5.1.3.2 Electrical Continuity Check

1. Select the DMM ohmmeter function and a low resistance scale.

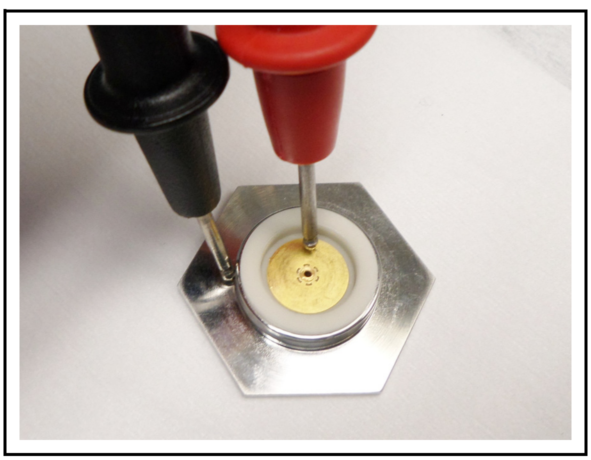
   NOTE: The resistance specifications in the following steps do not take into account the resistance of the Digital Multimeter probes. Touch the probe tips together and note the resistance reading. Compensate for probe resistance by subtracting probe resistance from resistance measurements, or by zeroing the ohmmeter while the probes are touching.

2. Remove the ceramic retainer and crystal from the crystal holder, and then reinstall the ceramic retainer into the crystal holder without a crystal.

3. Measure the resistance between the ceramic retainer and crystal holder as shown by Figure 5-2.

   - If resistance is less than 0.3 ohm (Ω), continue to step 4.
   - If resistance is more than 0.3 Ω, correct the cause of the high resistance before continuing to step 4. Check the following:
     - Cleanliness of the crystal seating surface inside the crystal holder (refer to section 4.3.2 on page 4-6).
     - Angle of the leaf spring on the ceramic retainer (refer to section 4.3.1 on page 4-5).
     - Verify that the leaf spring and circular plate on the ceramic retainer are tightly held together by the rivet.

Figure 5-2 Resistance between ceramic retainer and crystal holder



4. Install the crystal holder with ceramic retainer into the bakeable sensor.

5. At the BNC connector on the bakeable sensor feedthrough, measure the resistance between the center contact and shield (refer to Figure 5-1).

   - If resistance is less than 1 Ω, electrical continuity is good.
   - If resistance is more than 1 Ω, contact INFICON (refer to section 1.3 on page 1-2.)