OPERATING MANUAL

ALD Sensor

PN 074-643-P1A

INFICON

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

ALD Sensor

PN 074-643-P1A

INFICON Instruments for Intelligent Control®

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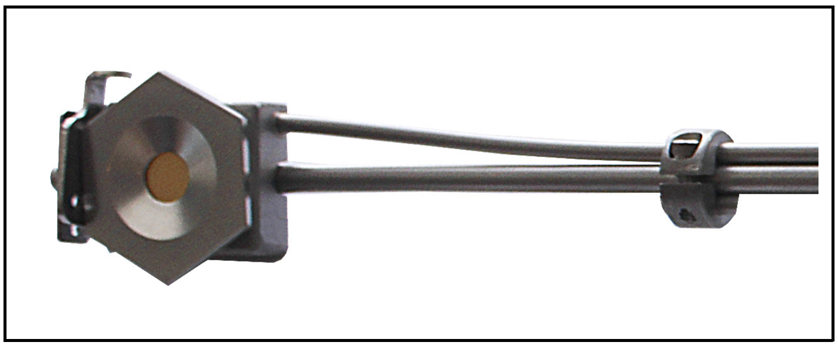
Chapter 1
Introduction and Specifications

1.1 Introduction

The INFICON ALD Sensor (see Figure 1-1) brings quartz crystal microbalance (QCM) measurement to atomic layer deposition (ALD). The ALD Sensor can withstand operational temperatures up to 450°C and is designed to operate in the harsh environment of an ALD application.

A gas tube is used to purge the back of the crystal and sensor cavity with an inert gas, typically nitrogen. This keeps reactive chamber gases from entering the sensor head and keeps the back of the crystal and electrical contacts free of deposition material.

Figure 1-1 ALD Sensor



ALD Sensors are available in custom welded lengths or with O-ring compression fittings for adjustable length without the need for brazing or welding. All configurations use a CF40 (2¾ in. ConFlat®) feedthrough.

The exposed crystal electrode is fully grounded to 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 Notes, 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 an ALD Sensor, please have the following information readily available:

- The Sales Order or Purchase Order number of the ALD Sensor purchase.
- The Lot Identification Code, located on the circumference of the flange.
- A description of the problem.
- The exact wording of any instrument error messages that may have been received.
- An explanation of any corrective action that may have already been attempted.

1.3.1 Returning the ALD 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. ALD 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 ALD 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 ALD 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 an 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, ALD Sensor Installation.
5. For additional information or technical assistance, contact INFICON (refer to section 1.3 on page 1-2).

1.4.1 ALD Sensor Configurations

Welded ALD Sensor. . . . . PN 750-713-G4

Adjustable ALD Sensor,
101.6 to 393.7 mm (4 to 15.5 in.) . . . . PN 750-717-G2

Adjustable ALD Sensor,
101.6 to 901.7 mm (4 to 35.5 in.) . . . . PN 750-717-G4

1.4.1.1 Accessories

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

Crystal Snatcher. . . . . PN 008-007

Graphite in Isopropyl Alcohol . . . . PN 009-175

1.4.2 High Temperature Crystals

120°C optimized crystals, 6 MHz,
14 mm (0.55 in.), gold, pack of 10 . . . . PN 750-1058-G10

240°C optimized crystals, 6 MHz,
14 mm (0.55 in.), gold, pack of 10 . . . . PN 750-1059-G10

285°C optimized crystals, 6 MHz,
14 mm (0.55 in.), gold, pack of 10 . . . . PN 750-1060-G10

1.5 Specifications

1.5.1 Welded ALD Sensor (PN 750-713-G4)

Maximum Temperature	450°C continuous
Sensor Head Size (maximum envelope)	34 x 35 x 24 mm (1.35 x 1.38 x 0.94 in.)
Tubes	
Gas	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

1.5.1.1 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

1.5.2 Adjustable ALD Sensor (PN 750-717-G2 and G4)

Maximum Temperature	130°C continuous
Sensor Head Size (maximum envelope)	34 x 35 x 31 mm (1.35 x 1.38 x 1.21 in.)
Tubes	
Gas	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

1.5.2.1 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
O-ring Compression Fittings	304 stainless steel, Viton®

1.5.3 Installation Requirements

Feedthrough	CF40 (2¾ in. ConFlat) feedthrough, integral with sensor head
Other	XIU or oscillator to match specific controller/monitor User-supplied means of attaching gas tube to purge gas supply

1.6 ALD Sensor Drawings

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

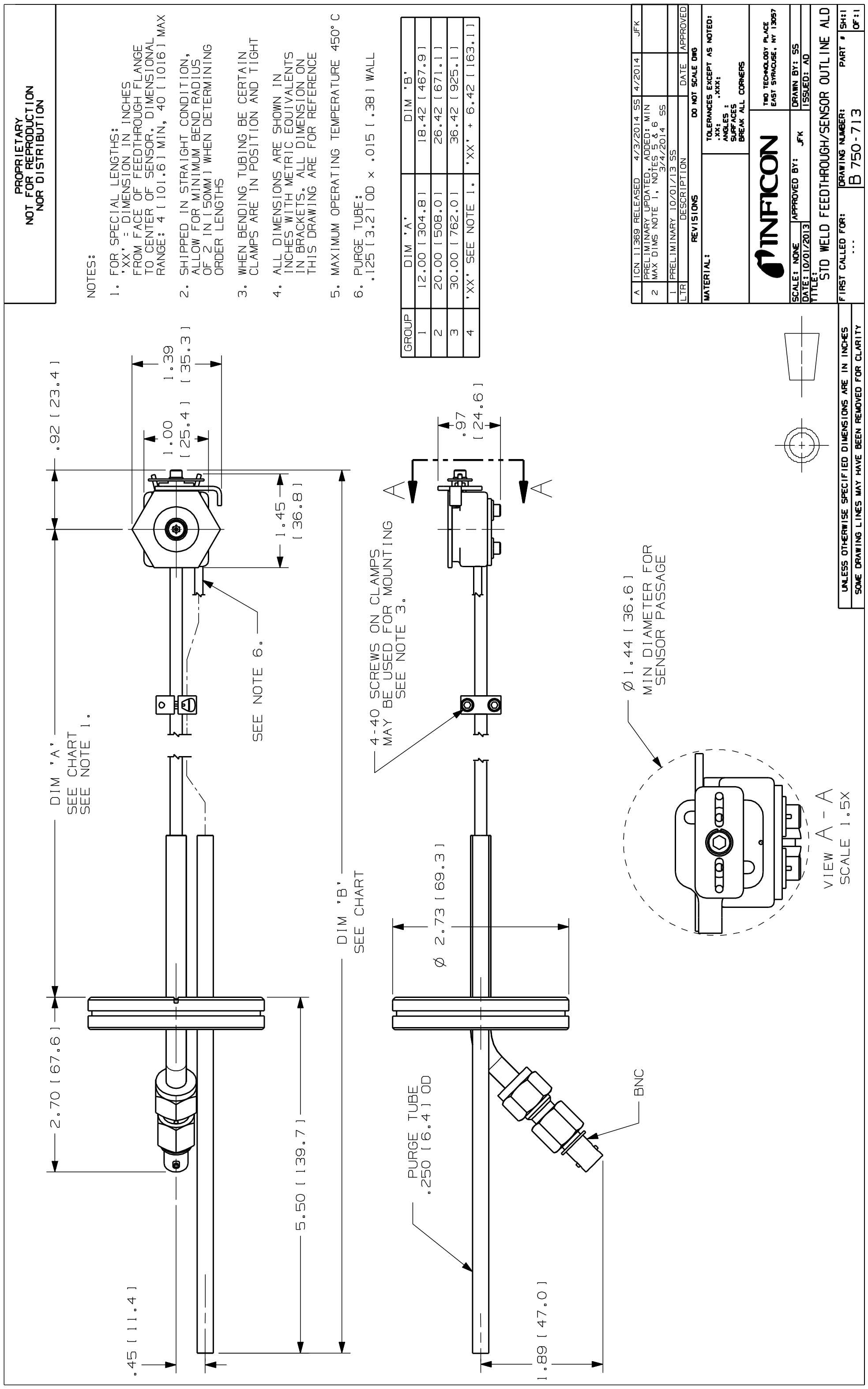
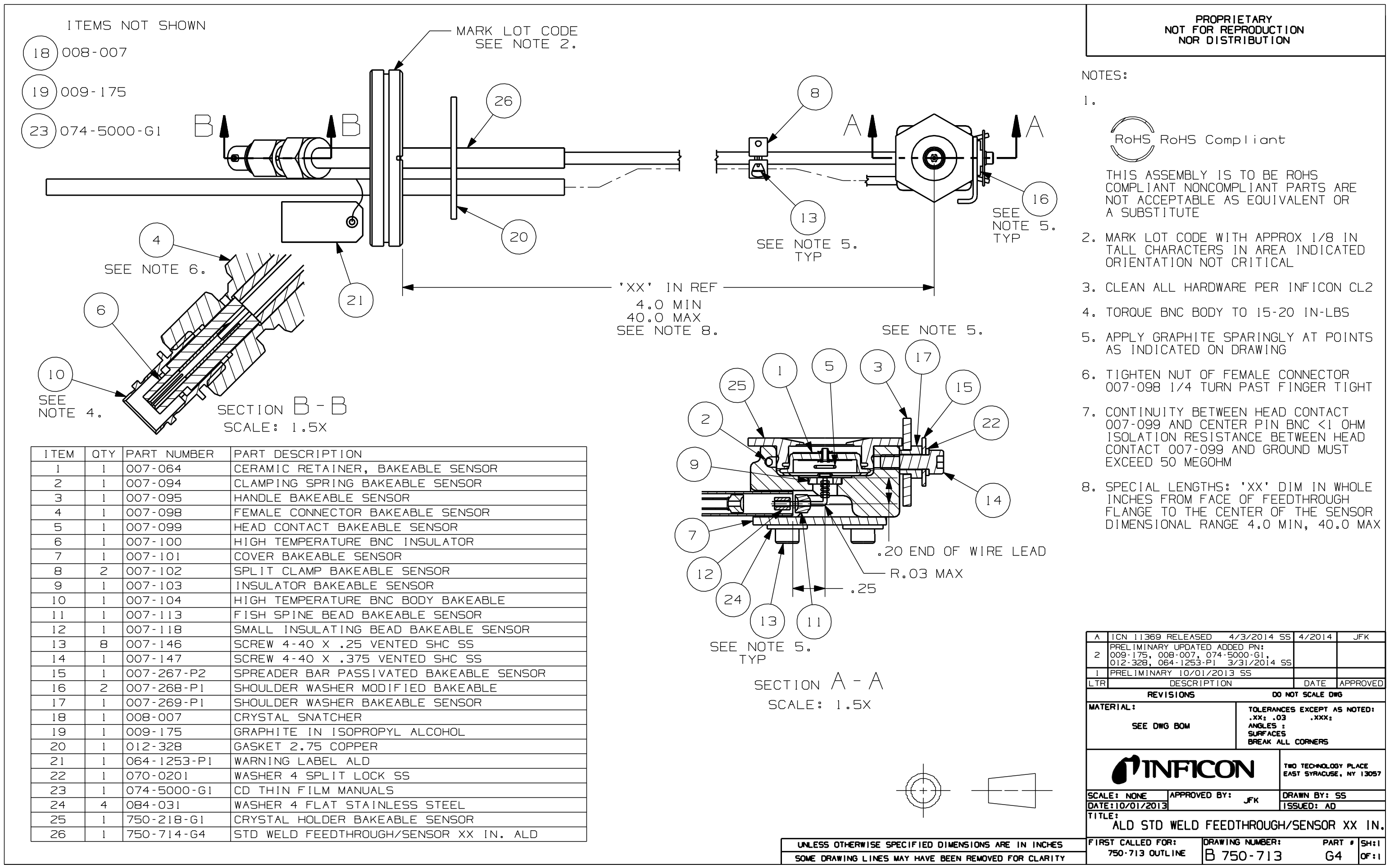


Figure 1-2 Welded ALD Sensor (PN 750-713-G4) outline

PN 074-643-P1A



ITEM	QTY	PART NUMBER	PART DESCRIPTION
1	1	007-064	CERAMIC RETAINER, BAKEABLE SENSOR
2	1	007-094	CLAMPING SPRING BAKEABLE SENSOR
3	1	007-095	HANDLE BAKEABLE SENSOR
4	1	007-098	FEMALE CONNECTOR BAKEABLE SENSOR
5	1	007-099	HEAD CONTACT BAKEABLE SENSOR
6	1	007-100	HIGH TEMPERATURE BNC INSULATOR
7	1	007-101	COVER BAKEABLE SENSOR
8	2	007-102	SPLIT CLAMP BAKEABLE SENSOR
9	1	007-103	INSULATOR BAKEABLE SENSOR
10	1	007-104	HIGH TEMPERATURE BNC BODY BAKEABLE
11	1	007-113	FISH SPINE BEAD BAKEABLE SENSOR
12	1	007-118	SMALL INSULATING BEAD BAKEABLE SENSOR
13	8	007-146	SCREW 4-40 X .25 VENTED SHC SS
14	1	007-147	SCREW 4-40 X .375 VENTED SHC SS
15	1	007-267-P2	SPREADER BAR PASSIVATED BAKEABLE SENSOR
16	2	007-268-P1	SHOULDER WASHER MODIFIED BAKEABLE
17	1	007-269-P1	SHOULDER WASHER BAKEABLE SENSOR
18	1	008-007	CRYSTAL SNATCHER
19	1	009-175	GRAPHITE IN ISOPROPYL ALCOHOL
20	1	012-328	GASKET 2.75 COPPER
21	1	064-1253-P1	WARNING LABEL ALD
22	1	070-0201	WASHER 4 SPLIT LOCK SS
23	1	074-5000-G1	CD THIN FILM MANUALS
24	4	084-031	WASHER 4 FLAT STAINLESS STEEL
25	1	750-218-G1	CRYSTAL HOLDER BAKEABLE SENSOR
26	1	750-714-G4	STD WELD FEEDTHROUGH/SENSOR XX IN. ALD

Figure 1-3 Welded ALD Sensor (PN 750-713-G4) assembly drawing

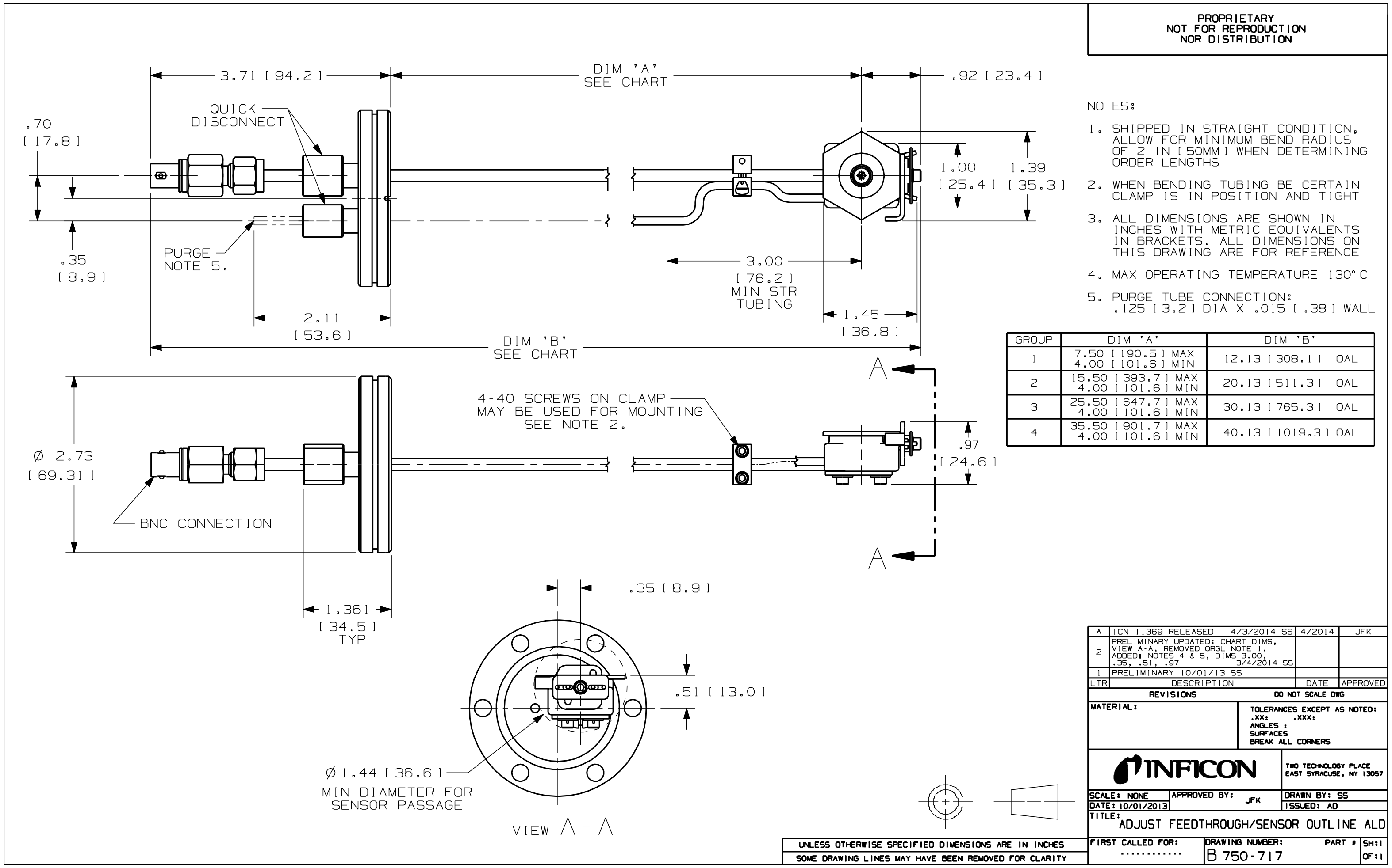
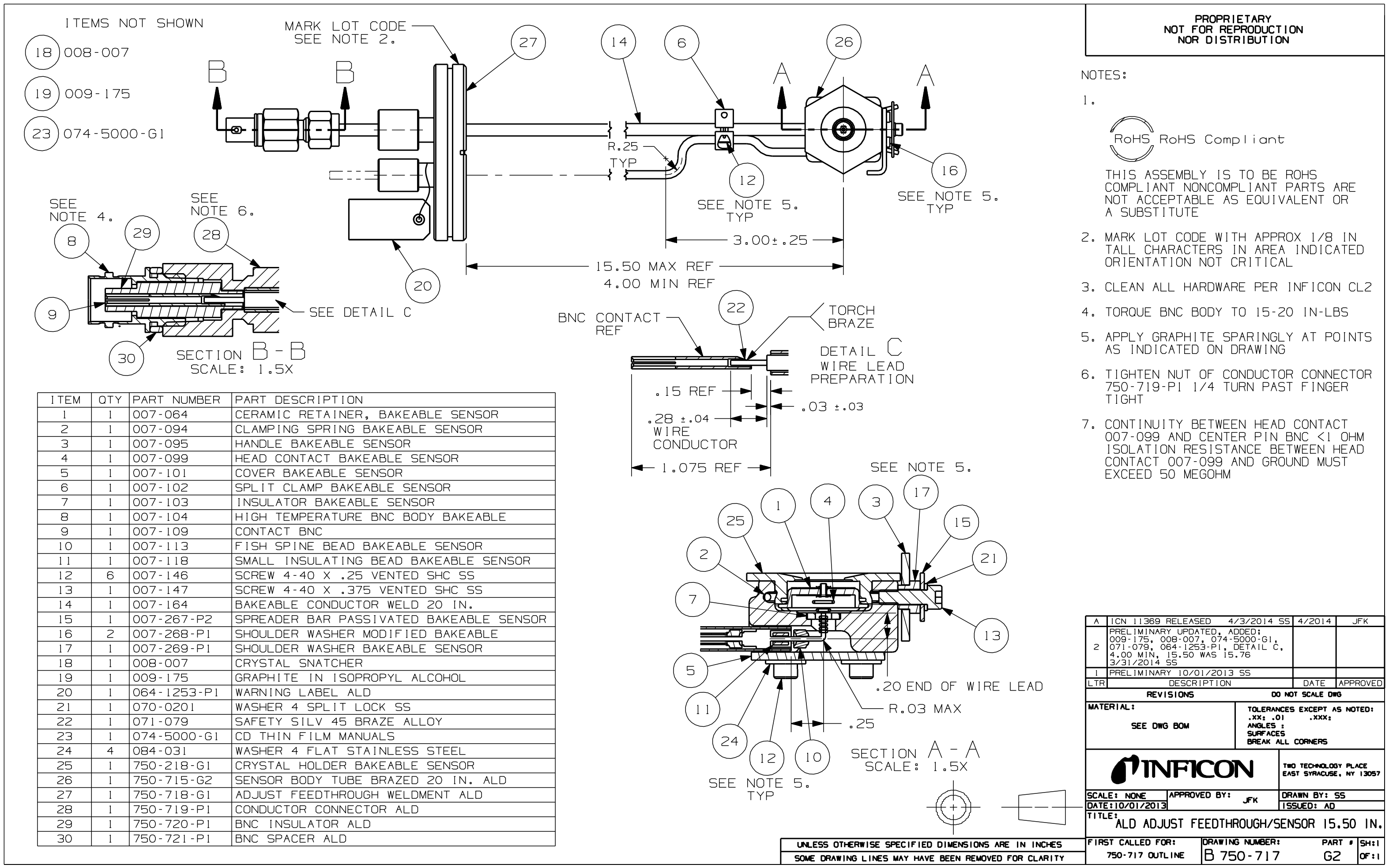
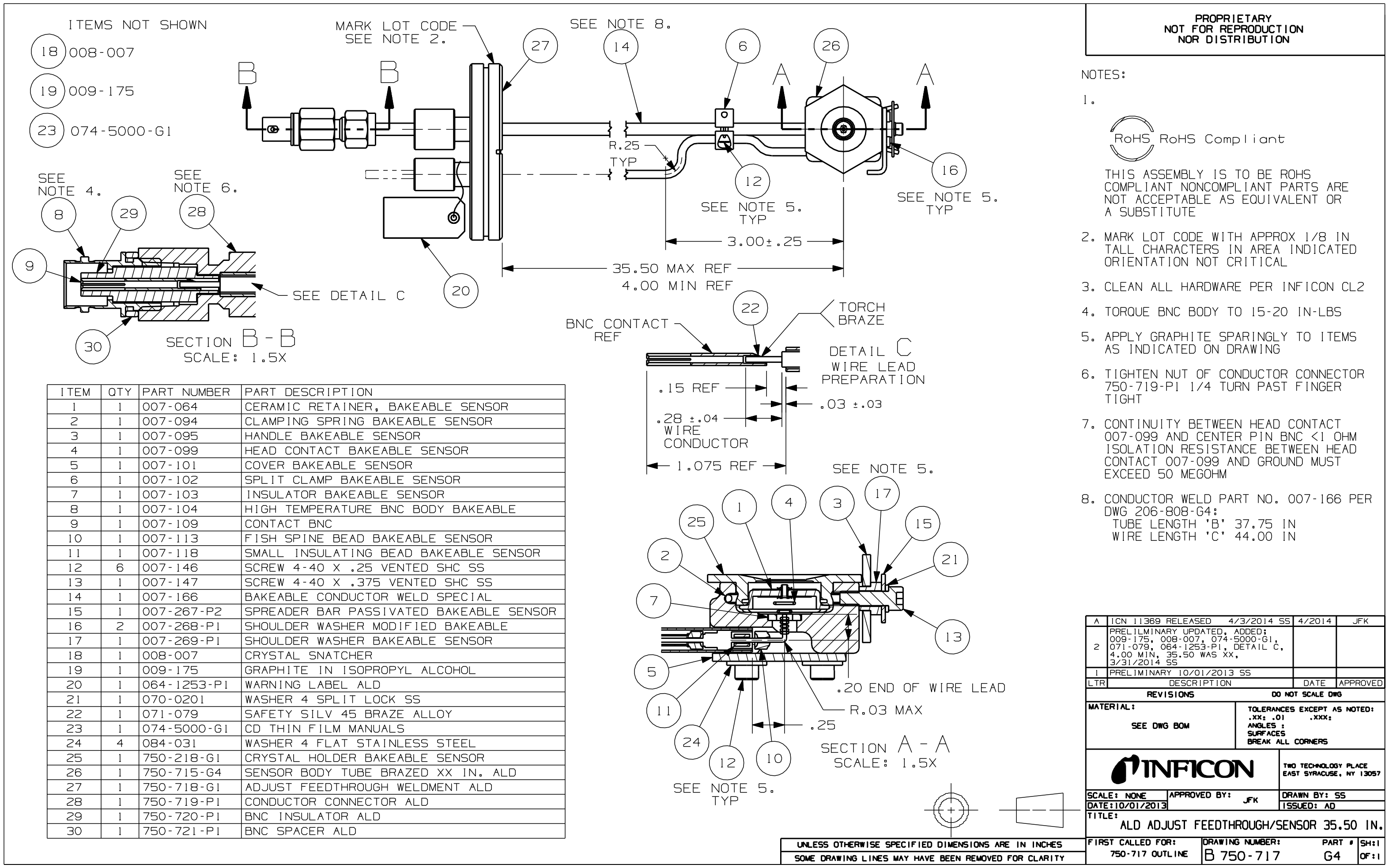


Figure 1-4 Adjustable ALD Sensor (PN 750-717-G2 and 750-717-G4) outline



ITEM	QTY	PART NUMBER	PART DESCRIPTION
1	1	007-064	CERAMIC RETAINER, BAKEABLE SENSOR
2	1	007-094	CLAMPING SPRING BAKEABLE SENSOR
3	1	007-095	HANDLE BAKEABLE SENSOR
4	1	007-099	HEAD CONTACT BAKEABLE SENSOR
5	1	007-101	COVER BAKEABLE SENSOR
6	1	007-102	SPLIT CLAMP BAKEABLE SENSOR
7	1	007-103	INSULATOR BAKEABLE SENSOR
8	1	007-104	HIGH TEMPERATURE BNC BODY BAKEABLE
9	1	007-109	CONTACT BNC
10	1	007-113	FISH SPINE BEAD BAKEABLE SENSOR
11	1	007-118	SMALL INSULATING BEAD BAKEABLE SENSOR
12	6	007-146	SCREW 4-40 X .25 VENTED SHC SS
13	1	007-147	SCREW 4-40 X .375 VENTED SHC SS
14	1	007-164	BAKEABLE CONDUCTOR WELD 20 IN.
15	1	007-267-P2	SPREADER BAR PASSIVATED BAKEABLE SENSOR
16	2	007-268-P1	SHOULDER WASHER MODIFIED BAKEABLE
17	1	007-269-P1	SHOULDER WASHER BAKEABLE SENSOR
18	1	008-007	CRYSTAL SNATCHER
19	1	009-175	GRAPHITE IN ISOPROPYL ALCOHOL
20	1	064-1253-P1	WARNING LABEL ALD
21	1	070-0201	WASHER 4 SPLIT LOCK SS
22	1	071-079	SAFETY SILV 45 BRAZE ALLOY
23	1	074-5000-G1	CD THIN FILM MANUALS
24	4	084-031	WASHER 4 FLAT STAINLESS STEEL
25	1	750-218-G1	CRYSTAL HOLDER BAKEABLE SENSOR
26	1	750-715-G2	SENSOR BODY TUBE BRAZED 20 IN. ALD
27	1	750-718-G1	ADJUST FEEDTHROUGH WELDMENT ALD
28	1	750-719-P1	CONDUCTOR CONNECTOR ALD
29	1	750-720-P1	BNC INSULATOR ALD
30	1	750-721-P1	BNC SPACER ALD

Figure 1-5 Adjustable ALD Sensor (PN 750-717-G2) assembly drawing



ITEM	QTY	PART NUMBER	PART DESCRIPTION
1	1	007-064	CERAMIC RETAINER, BAKEABLE SENSOR
2	1	007-094	CLAMPING SPRING BAKEABLE SENSOR
3	1	007-095	HANDLE BAKEABLE SENSOR
4	1	007-099	HEAD CONTACT BAKEABLE SENSOR
5	1	007-101	COVER BAKEABLE SENSOR
6	1	007-102	SPLIT CLAMP BAKEABLE SENSOR
7	1	007-103	INSULATOR BAKEABLE SENSOR
8	1	007-104	HIGH TEMPERATURE BNC BODY BAKEABLE
9	1	007-109	CONTACT BNC
10	1	007-113	FISH SPINE BEAD BAKEABLE SENSOR
11	1	007-118	SMALL INSULATING BEAD BAKEABLE SENSOR
12	6	007-146	SCREW 4-40 X .25 VENTED SHC SS
13	1	007-147	SCREW 4-40 X .375 VENTED SHC SS
14	1	007-166	BAKEABLE CONDUCTOR WELD SPECIAL
15	1	007-267-P2	SPREADER BAR PASSIVATED BAKEABLE SENSOR
16	2	007-268-P1	SHOULDER WASHER MODIFIED BAKEABLE
17	1	007-269-P1	SHOULDER WASHER BAKEABLE SENSOR
18	1	008-007	CRYSTAL SNATCHER
19	1	009-175	GRAPHITE IN ISOPROPYL ALCOHOL
20	1	064-1253-P1	WARNING LABEL ALD
21	1	070-0201	WASHER 4 SPLIT LOCK SS
22	1	071-079	SAFETY SILV 45 BRAZE ALLOY
23	1	074-5000-G1	CD THIN FILM MANUALS
24	4	084-031	WASHER 4 FLAT STAINLESS STEEL
25	1	750-218-G1	CRYSTAL HOLDER BAKEABLE SENSOR
26	1	750-715-G4	SENSOR BODY TUBE BRAZED XX IN. ALD
27	1	750-718-G1	ADJUST FEEDTHROUGH WELDMENT ALD
28	1	750-719-P1	CONDUCTOR CONNECTOR ALD
29	1	750-720-P1	BNC INSULATOR ALD
30	1	750-721-P1	BNC SPACER ALD

Figure 1-6 Adjustable ALD Sensor (PN 750-717-G4) assembly drawing

Chapter 2
ALD Sensor Installation

2.1 Pre-installation Sensor Check

Prior to installing the sensor in the ALD 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 3.2 on page 3-3.
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 2-4).

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 783-500-013) labeled **Sensor**.
3. Connect one end of the oscillator cable (PN 782-902-012-XX) to the mating connector of the oscillator labeled **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 3.2 on page 3-3.
6. Connect power to the controller or monitor.
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 2-4).

2.1.3 Sensor Check with 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 STM-2.

3 Connect one end of the USB cable (PN 068-0472) to the mating connector of STM-2.

4 Connect the other end of the USB cable to a USB port on the computer being used to operate STM-2.

5 Install the crystal as instructed by section 3.2 on page 3-3.

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 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 2-4).

2.2 Sensor Installation Guidelines

Install the sensor as close to the substrate as possible to accumulate thickness at a rate proportional to accumulation on the substrate and eliminate variations in the reaction.

Plan the installation to ensure that the sensor does not disrupt the flow of reactive gases in the chamber.

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

2.3 Sensor Installation Procedure

CAUTION

The ALD Sensor should be clean and free of grease when installed in the ALD chamber. Clean nylon or talc-free latex lab gloves should be worn while handling sensor components.

If sensor components become contaminated, clean them thoroughly using a suitable solvent to avoid outgassing.

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

   NOTE: Four #4-40 thread holes are provided on the back of the sensor head for attaching the ALD 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 2-5.
3. Install a Viton quad ring or copper gasket (process dependent) against the knife-edge of the flange.
4. Connect the sensor feedthrough to the mating flange on the vacuum chamber.
5. 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.)

6. Connect the external gas tube from the feedthrough to the purge gas supply.

   NOTE: A user-supplied means of attaching gas tube to purge gas supply is required.

WARNING

Provide a shut off valve for the purge tube to prevent process gases from escaping.

Plug purge tube when disconnected to prevent process gases from escaping.

7. Apply purge gas at the desired rate and verify that the gas connections are tight.
8. Refer to section 1.5 on page 1-5 for other installation requirements, including maximum operating temperatures.

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 ALD 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 ALD Sensors that include one clamp, 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 a loss of vacuum integrity or short the wire providing the 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 gas tube is collapsed or pinched, gas flow will be restricted. The sensor will not have sufficient gas flow to purge the inside of the sensor.
  - 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.

Gas 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).

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Chapter 3
Maintenance and Spare Parts

3.1 General Precautions

CAUTION

The ALD Sensor should be clean and free of grease when installed in the ALD chamber. Clean nylon or talc-free latex lab gloves should be worn while handling sensor components.

If sensor components become contaminated, clean them thoroughly using a suitable solvent to avoid outgassing.

3.1.1 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.

3.1.2 Maintain the Temperature of the Crystal

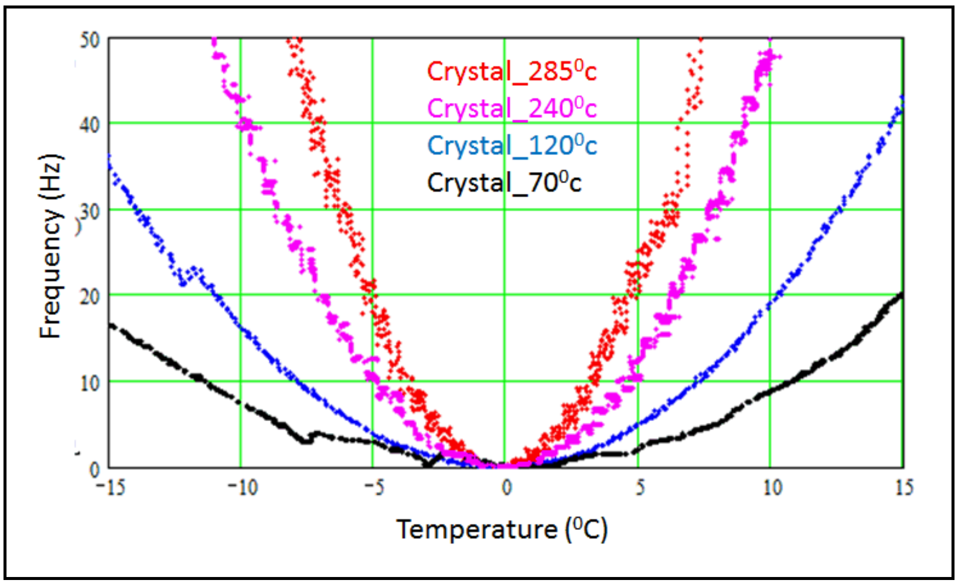
ALD uses two precursors that react to deposit material (metals or metal oxides) one atomic monolayer at a time. Most ALD reactions are temperature dependent, and the crystal must remain at the reaction temperature.

Water cooling cannot be used during an ALD process to cool the crystal and maintain the optimal temperature for standard INFICON crystals. High Temperature ALD crystals are recommended for ALD applications for this reason.

High Temperature crystals are 6 MHz, gold-coated crystals that are optimized at 120, 240, or 285°C (refer to section 1.4.2 on page 1-4). These crystals have a smaller range of temperatures that deliver stable and accurate thickness readings (see Figure 3-1).

NOTE: Please contact INFICON for custom crystals optimized for additional temperatures (refer to section 1.3 on page 1-2).

Figure 3-1 High temperature crystal frequency error



The graph represents the temperature change from optimal temperature (°C) and the resulting frequency error due to the temperature change.

NOTE: The optimization temperatures of the High Temperature crystals (120, 240, or 285°C) as well as standard INFICON crystals (70°C) have been normalized to zero to be able to compare the temperature range of all offerings on one graph.

- 70°C crystals display a stable frequency in a temperature range of 59 to 81°C.
- 120°C crystals display a stable frequency in a temperature range of 112 to 128°C.
- 240°C crystals display a stable frequency in a temperature range of 235 to 245°C.
- 285°C crystals display a stable frequency in a temperature range of 281 to 289°C.

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3.2 Crystal Replacement Instructions

Follow the steps below to replace the crystals.

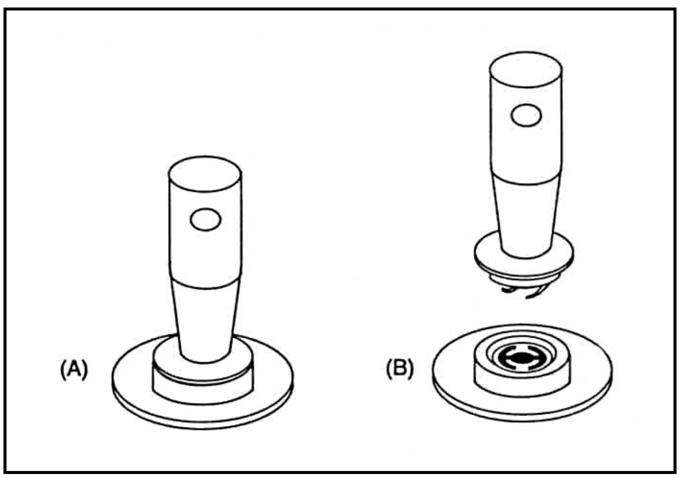
NOTE: Review section 3.1, General Precautions, on page 3-1.

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 3-2 (**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 3-2 (**B**)).

Figure 3-2 Using the crystal snatcher



3. Invert the crystal holder and the crystal will drop out.
4. Prior to installing the new crystal, review section 3.1.1, Handle the Crystal with Care, on page 3-1.
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 sensor body, then latch the clamping spring handle.

CAUTION

Never deposit material on a sensor unless the crystal holder and crystal are installed and purge gas is flowing through the sensor.

Material deposited on the interior of the 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.

3.3 ALD Sensor Maintenance

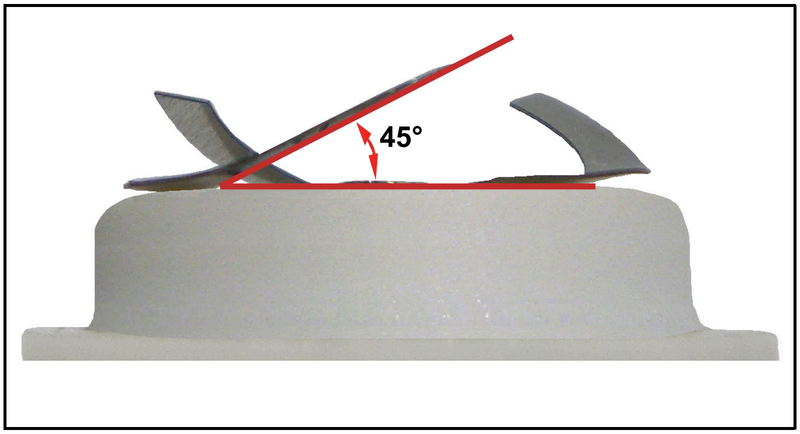
3.3.1 Adjusting the Leaf Spring

ALD Sensors have a leaf spring comprised of three spring segments located on the ceramic retainer that provides an electrical connection to the crystal electrode.

Examine each of the spring segments on the leaf spring positioned on the ceramic retainer. If they are significantly lower than shown by Figure 3-3, they should be adjusted to an angle of approximately 45 degrees.

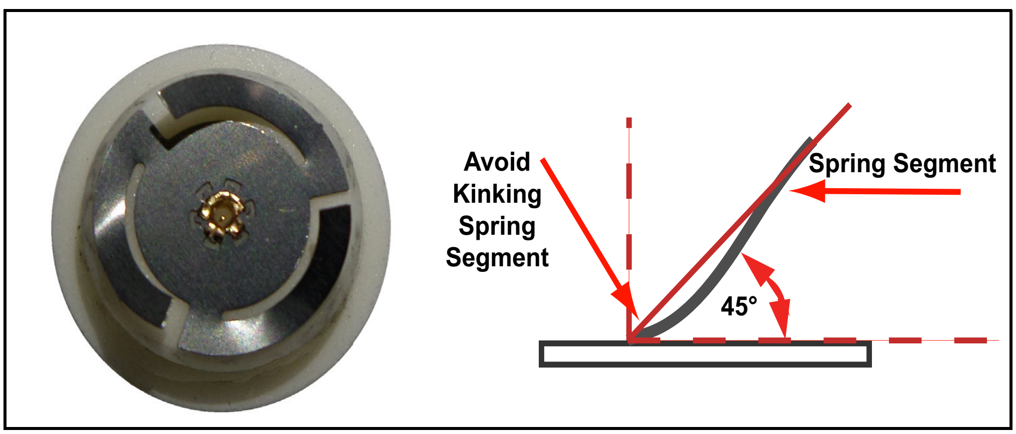
NOTE: A leaf spring adjusted to 45 degrees will flatten slightly after being inserted into and extracted from the crystal holder.

Figure 3-3 Ceramic retainer



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

Figure 3-4 Leaf spring shape



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3.3.2 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 ALD process can cause a poor electrical contact between the crystal and the crystal holder. A poor electrical contact will result in noisy operation and early crystal failure.

Cleaning may be accomplished by following three steps:

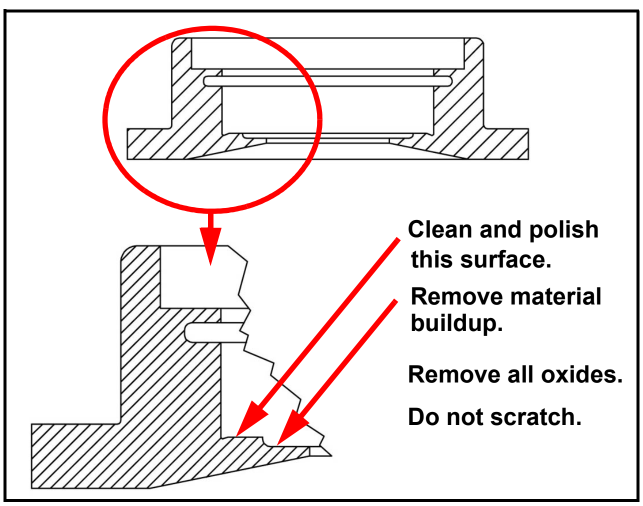
1. Gently buffing the crystal seating surface in the crystal holder with a white, #7445 Scotch-Brite™ cleaning pad (see Figure 3-5).
2. Washing the crystal seating surface in the crystal holder in an ultrasonic bath in soap solution.
3. Thorough rinsing of the crystal seating surface in the crystal holder 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 3-5 Crystal holder cleaning



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3.3.3 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.

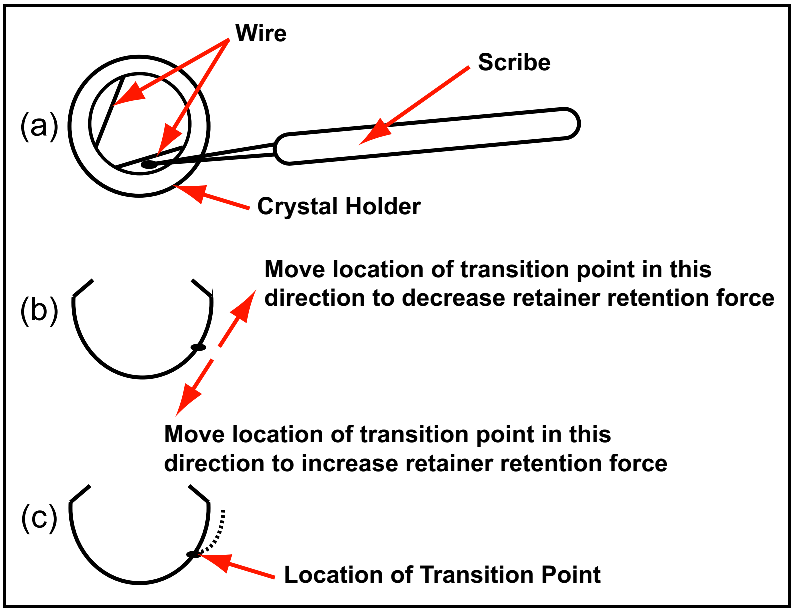
Tools required

- 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 3-6 (**a**)).

Figure 3-6 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 3-6 (**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 3-6 (**c**) to remove the existing transition point.
6. Use both pliers to form a new transition point according to Figure 3-6 (**b**), thus returning the spring to a shape similar to the solid line delineation of Figure 3-6 (**c**).

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

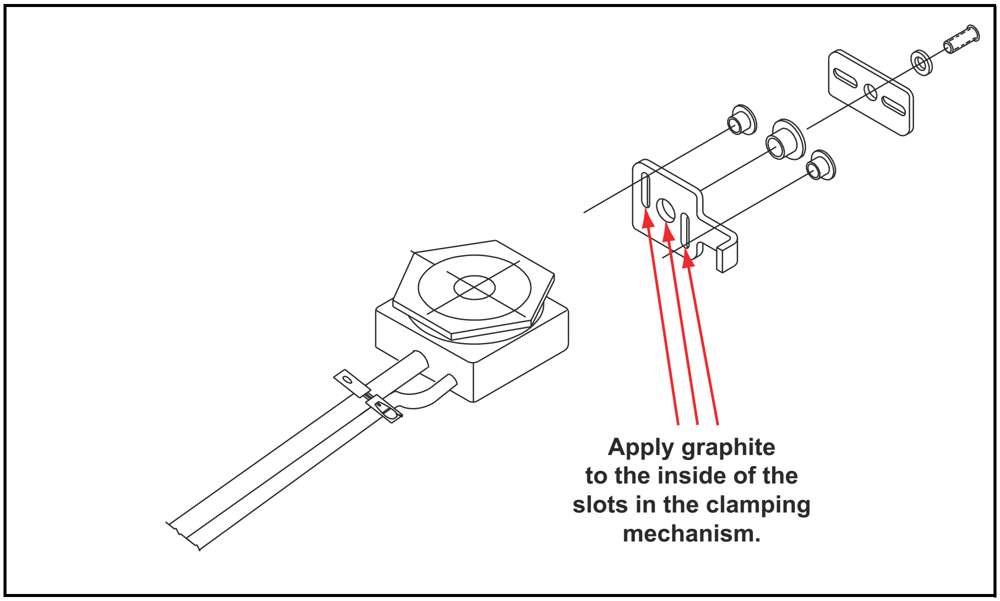
8 Install the ceramic retainer and determine if the retention force is acceptable and that the wire does not impede crystal insertion. If needed, repeat the adjustment procedure.

3.3.4 Lubricating the Clamping Mechanism

If operation is impaired, lubricate moving parts with graphite (PN 009-175) if appropriate for the process.

The clamping mechanism may need to be lubricated on ALD Sensors (see Figure 3-7).

Figure 3-7 Lubricating the clamping mechanism



3.4 Replacement Parts and Accessories

Ceramic Retainer . . . . PN 007-064

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

Crystal Snatcher. . . . . PN 008-007

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Chapter 4
Troubleshooting

4.1 Troubleshooting Tools

If the ALD 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 4.1.1)
- Diagnostic Tools (see section 4.1.2 on page 4-3)
- Digital Multimeter (see section 4.1.3 on page 4-4)

4.1.1 Symptom, Cause, Remedy

The Symptom, Cause, Remedy chart can help identify the causes of, and solutions to, sensor problems and related issues (see Table 4-1).

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.	
	Scratches or foreign particles on the crystal holder seating surface.	Clean or polish the crystal seating surface of the crystal holder (refer to section 3.3.2 on page 3-6).
	Particles on the crystal.	Remove source of particles and replace the crystal.
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 3.3.2 on page 3-6).
	Deposition material on crystal holder opening is partially masking the crystal.	
	Deposition material on interior of sensor body.	Check purge gas rate and flow. Remove material buildup from interior or sensor body and replace damaged components.
	Crystal life is highly dependent on process conditions of rate, temperature, location, material, and residual gas composition.	

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

SYMPTOM	CAUSE	REMEDY
Crystal does not oscillate or oscillates intermittently.	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 4.1.3 on page 4-4).
Crystal oscillates in chamber 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.
Thermal instability: large changes in thickness reading during deposition.	Crystal is not properly seated.	Check and clean the crystal seating surface of the crystal holder (refer to section 3.3.2 on page 3-6).
	Temperature fluctuations.	Maintain the temperature of the process near optimization temperature of the crystal (refer to section 3.1.2 on page 3-2). Select the crystal with an optimization temperature near the process temperature.
Poor thickness reproducibility.	Temperature fluctuations.	Maintain the temperature of the process near optimization temperature of the crystal (refer to section 3.1.2 on page 3-2). Select the crystal with an optimization temperature near the process temperature. Check the process temperature for proper operating conditions.
	Material does not adhere to the crystal.	Check the cleanliness of the crystal. Apply an intermediate layer of process-compatible material on the crystal to improve adhesion.

4.1.2 Diagnostic Tools

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

- STM-2 with 5.5 MHz test crystal (see section 4.1.2.1).
- OSC-100 oscillator test function (see section 4.1.2.2).
- PN 760-601-G2 Crystal Sensor Emulator (see section 4.1.2.3).
- XIU test function (see section 4.1.2.4).

4.1.2.1 STM-2 with 5.5 MHz Test Crystal

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

4.1.2.2 OSC-100 Test Function

1. Disconnect the short BNC cable from the BNC connector on the ALD 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 ALD 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, monitor, oscillator, or a cable is the cause of the crystal fail. Refer to the controller or monitor operating manual.

4.1.2.3 PN 760-601-G2 Crystal Sensor Emulator

1. Disconnect the short BNC cable from the BNC connector on the ALD 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 ALD Sensor is the cause of the crystal fail.
    - If the crystal fail is still present after 5 seconds, the controller, monitor, oscillator, XIU, or a cable is the cause of the crystal fail. Refer to the controller or monitor operating manual.

4.1.2.4 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.

4.1.3 Digital Multimeter

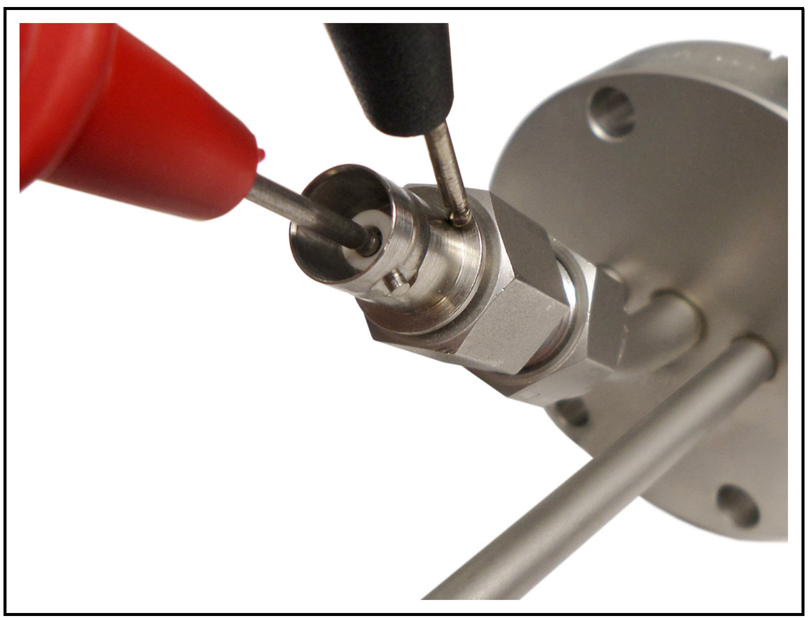
A useful tool for diagnosing sensor problems is the Digital Multimeter (DMM).

To isolate the cause of a sensor problem, perform electrical isolation and continuity checks, starting with the Electrical Isolation Check (section 4.1.3.1).

4.1.3.1 Electrical Isolation Check

1. Remove the crystal holder from the ALD Sensor.
2. Disconnect the BNC cable from the ALD 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 4-1.
   - If the resistance is more than 10 MΩ, electrical isolation is good. Go to section 4.1.3.2, Electrical Continuity Check, on page 4-5.
   - If the resistance is less than 10 MΩ, verify that the coil spring making contact with the crystal holder is not making contact with the sensor body. If it is not, contact INFICON (refer to section 1.3 on page 1-2).

Figure 4-1 BNC connector resistance



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4.1.3.2 Electrical Continuity Check

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

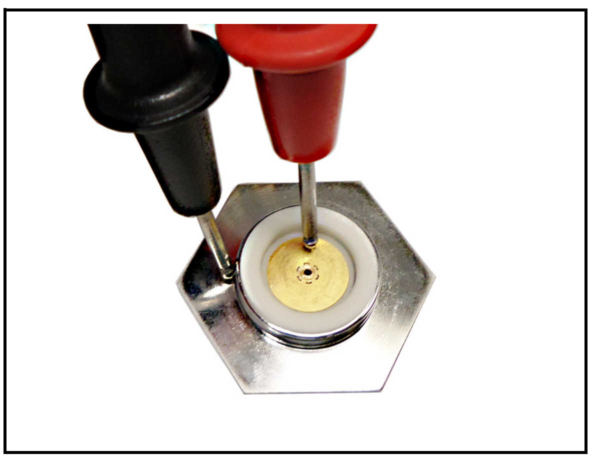
   NOTE: The resistance specifications in the following steps do not take into account the resistance of the Digital Multimeter probes. Touch the probe tips together and note the resistance reading. Compensate for probe resistance by subtracting probe resistance from resistance measurements, or by zeroing 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 4-2.

   - 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 3.3.2 on page 3-6).
     - Angle of the leaf spring on the ceramic retainer (refer to section 3.3.1 on page 3-5).
     - Verify that the leaf spring and the circular plate on the ceramic retainer are tightly held together by the rivet.

Figure 4-2 Resistance between ceramic retainer and crystal holder



4. Install the crystal holder with the ceramic retainer into the ALD Sensor.

5. At the BNC connector on the ALD Sensor feedthrough, measure the resistance between the center contact and shield (refer to Figure 4-1).

   - 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).

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