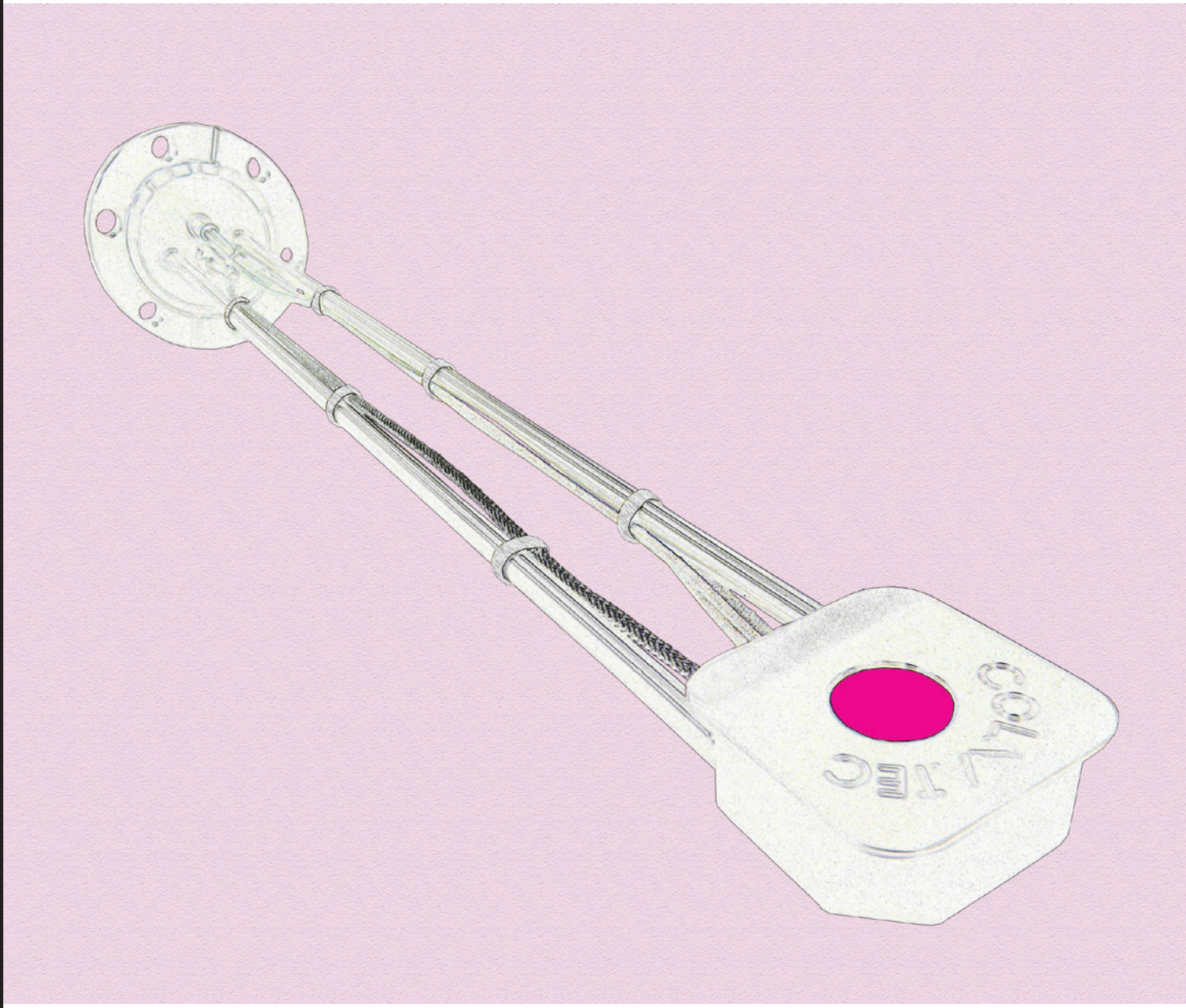
TEMPE™

self-heating thin film sensor



user manual

COLNATEC

WARNING All electrical components are to be considered extremely dangerous if tampered with in any way. Colnatec is not liable for any injury resulting from product misuse, modification, or disassembly.

The Tempe™ Sensor Head is designed to reach extreme temperatures; both the head and the exhaust line when it is cooling may reach temperatures approaching 500 ºC. Adequate safety precautions should be taken whenever operating the Tempe™ to prevent fire or burning.

WARRANTY LABEL If the warranty label has been tampered with, “VOID” will appear where the warranty label was originally placed. If this is visible at the time of arrival, it is important that you contact Colnatec immediately after receiving the product.

April 2014
Version 3.0

EXAMINE YOUR NEW TEMPE™ FOR ANY SIGNS OF PHYSICAL DAMAGE. ALSO, ENSURE THAT THE TAMPER-EVIDENT LABELS ARE INTACT Before shipping, your Tempe™ was inspected and tested by Colnatec to meet the highest quality standards. It is important that you take a few minutes to inspect the product to ensure that your equipment was not damaged or otherwise tampered with during transit.

What Is the Tempe™ Self-Heating Thin Film Sensor?

About Tempe™

Heating a thin film sensor head can serve a variety of important purposes. Some applications require elevated chamber temperatures. Because it is able to match and maintain temperatures inside the chamber (within a range of 50-500 ºC), the Tempe™ can provide accurate readings from the very beginning of the process. Other thin film sensors in this situation will *always* yield false readings, as the initial temperature of the sensor head will *always* be in disequilibrium with the temperature of the chamber.

Additionally, the unique ability of the Tempe™ to achieve extreme temperatures has the added benefit of extending crystal life indefinitely. Utilizing a “bake” process that heats the sensor head in situ, residual deposition material is burned away from the crystal. In most instances (depending on the type of material being deposited), the crystal can be restored to a fully operational state. This procedure both rejuvenates the crystal and reduces interruptions in a continuous process environment.

Inspection & Initial Setup

Please examine your Tempe™ for any signs of physical damage. In order to ensure safe, correct operation of your Tempe™, please follow the step-by-step instructions presented in the Tempe-Eon™ Quick Reference Guide included with your product.

Warranty

Tempe™ is warranted to the original purchaser to be free of any manufacturing-related defects for one year from the date of purchase. Colnatec reserves the right to repair or replace the unit after inspection.

Contact support@colnatec.com for more information.

Contents

Tables & Figures

Tables

Figures

Mirage™ Connection Cables
Air-cooling and relay cabling used with Mirage™.

Mirage™ Air Cooling System
Input 1/4" NPT Female Connection.

Power Supply
Input: 100-200VAC, 50/60Hz, 2.0A
Output: 24V-3.75A, 90W MAX.

Eon™ Thin Film Controller
Eon™ Controller has heater and RTD output/input, BNC sensor inputs, Type K Thermocouple inputs, power input, and RS-232 ComPort for connection to PC.

Power Supply Cable
North America standard plug (Europlug available on request).

RS-232 Extension Cable
Standard, male-to-female serial cable.

USB to RS-232 Adaptor

SMA to Microdot Cable

Quartz Crystals

Crystal Tool

Eon™ Software Disc
Eon™ software, Labview runtime, USB drivers, and manual.
Software requires administrative privileges to install and run.

Quick Reference Guide

Figure A: Eon™ Package Components

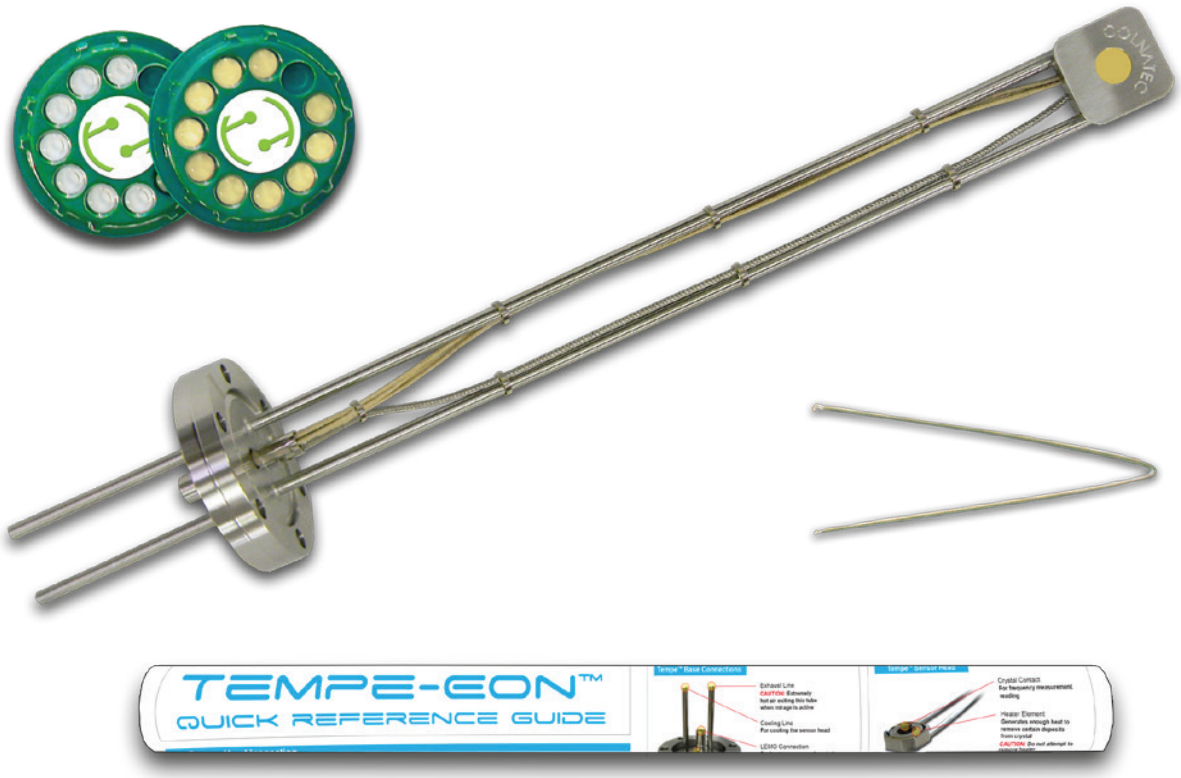


Figure B: Tempe™ Sensor Head

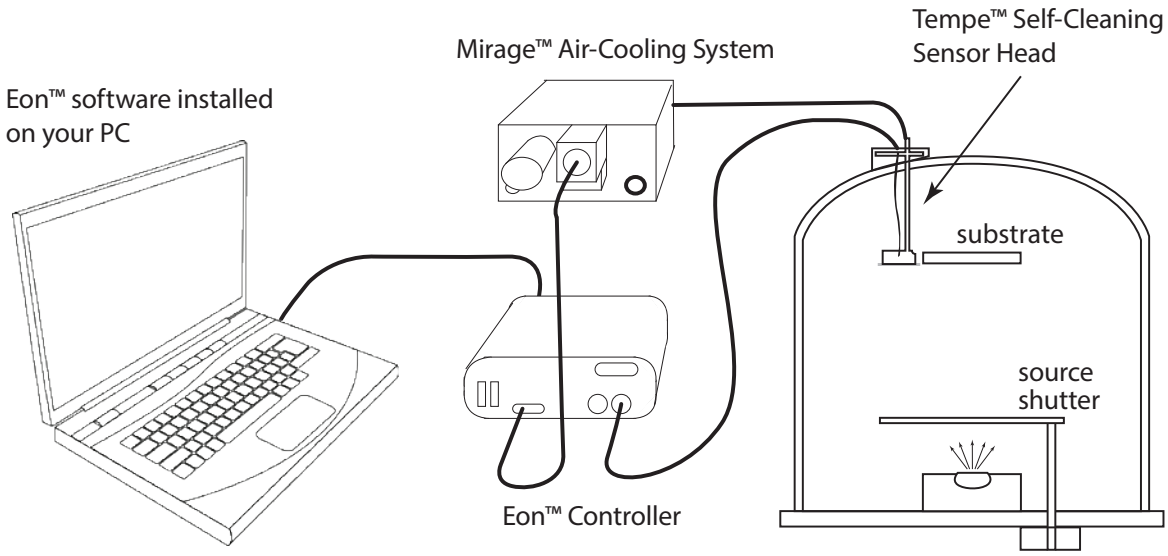
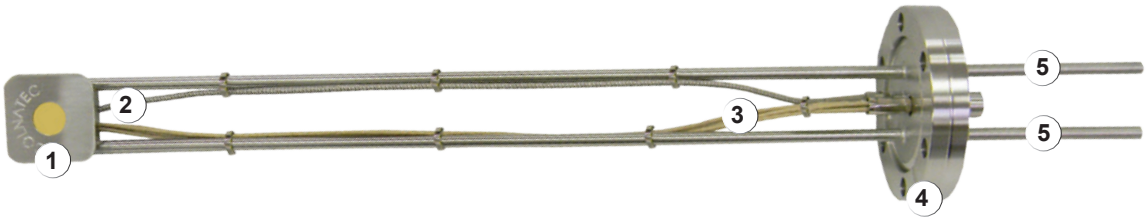


Figure C: Connections between Tempe™ System Components

2.0 Tempe™ Sensor Head Design

The sensor head features many sub-components. The usage of these components will be detailed in later sections.



1. Sensor Head
   Houses quartz crystal

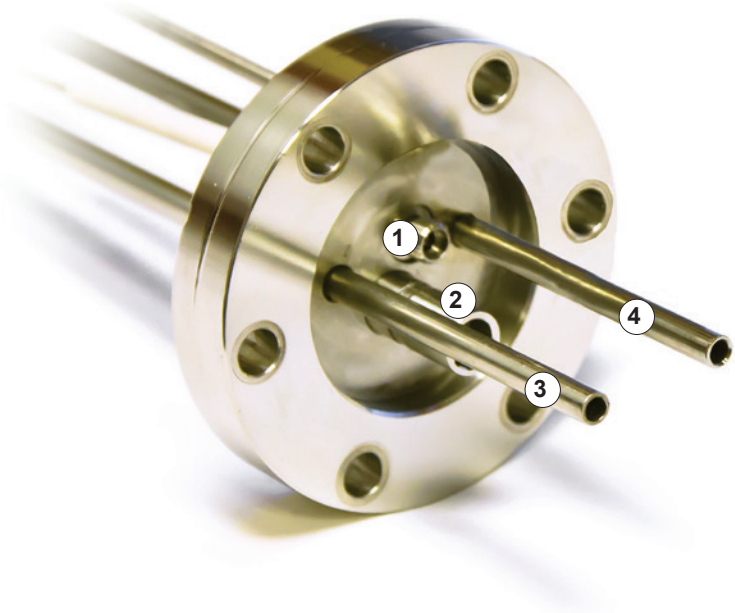
2. Heater Control Cable
   Controls heater

3. Crystal Signal Cables
   Relays crystal oscillation information

4. Flange
   Acts as nearly air-tight barrier sealing sensor head in chamber

5. Cooling Tubes
   Circulates forced air through sensor head

Figure D: Tempe™ Subcomponents



1. SMA Coaxial Connection
   For crystal frequency measurement

2. LEMO Connection
   For heater control

3. Cooling Line
   Channels cool air into sensor head

4. Exhaust Line
   Conveys hot air from sensor head

   WARNING Extremely hot air exiting this line when Mirage™ is active

Figure E: Tempe™ Base Subcomponents

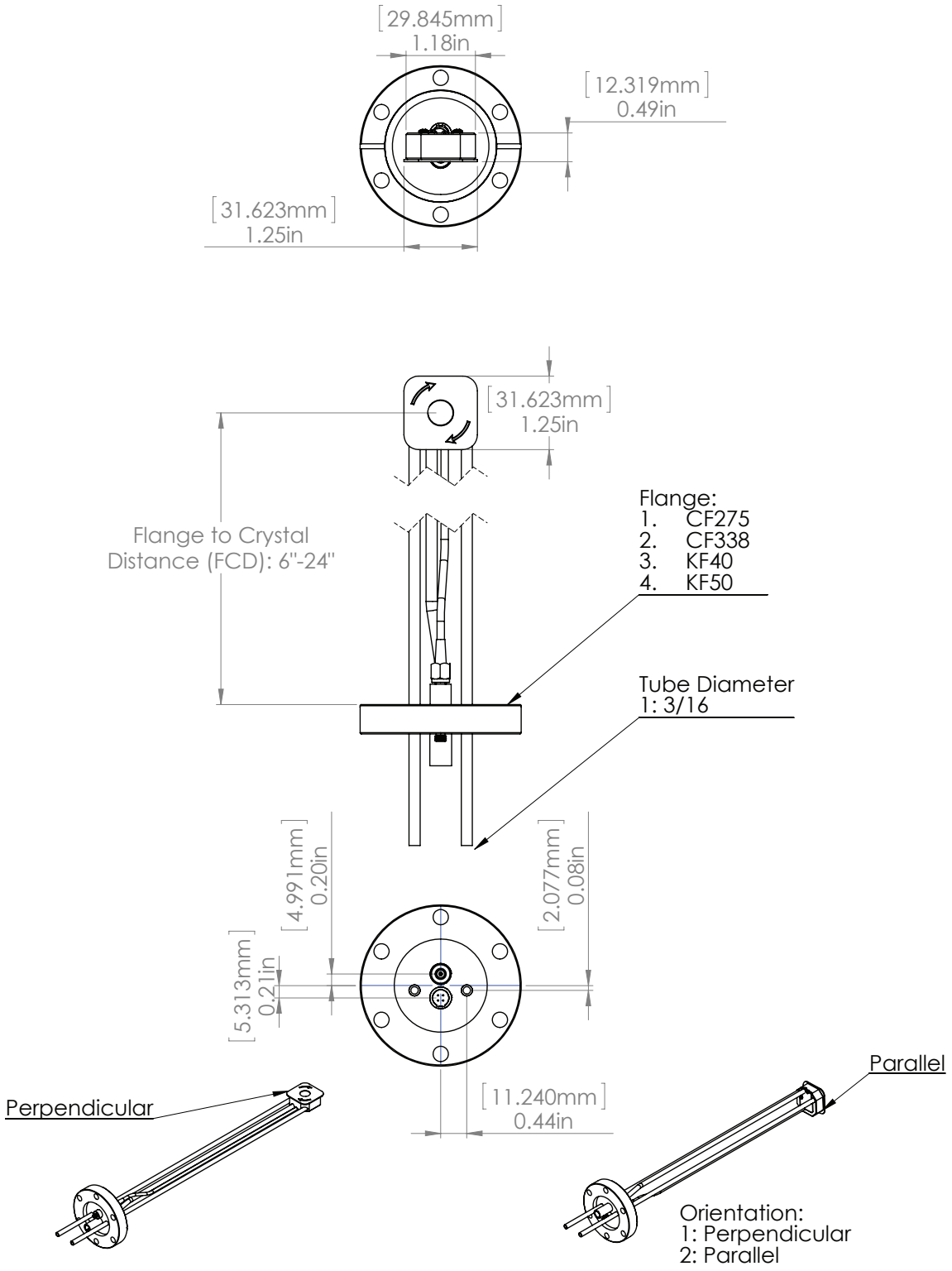


Figure F: Tempe™ Dimensions

Figure G: Eon™ Front Hardware Connections

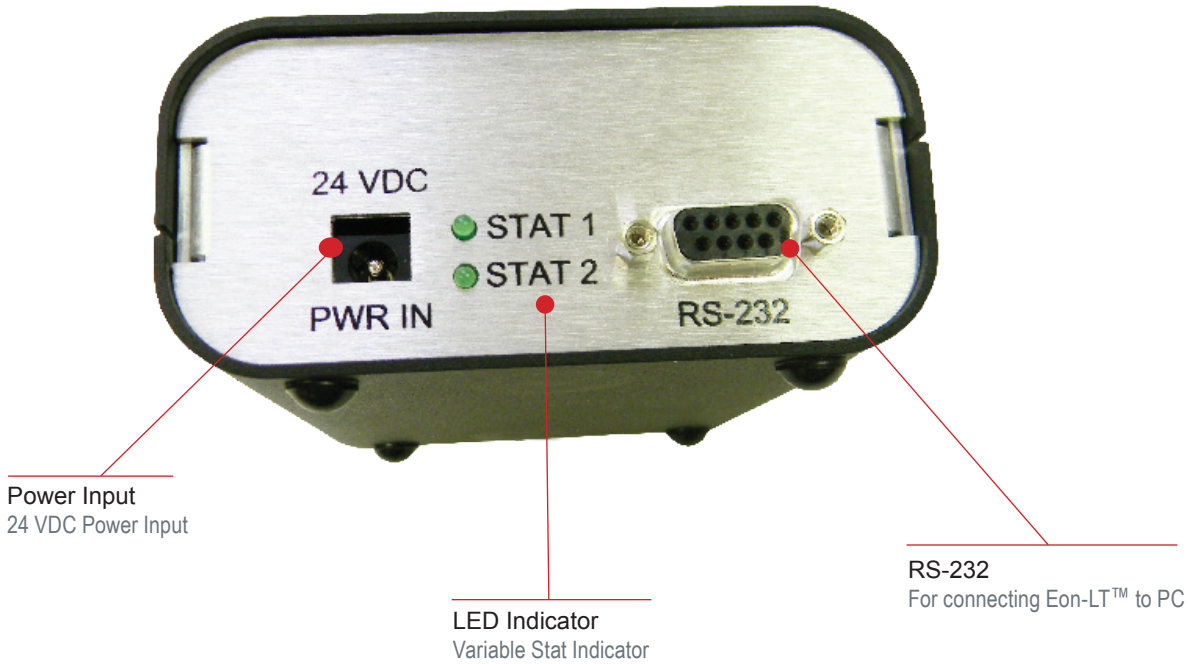


Figure H: Eon™ Rear Hardware Connections

Eon™ has been designed so that ONLY the correct hardware can be plugged into the appropriate input or output. The following is a guideline on how hardware should be connected in order to prevent damage to Eon™.

3.0 Connecting Inputs

The Eon™ utilizes five (5) inputs. Make sure the correct hardware is used with these inputs.

3.0.1 Power

Only the provided power supply should be used with Eon™. Not doing so will cause hardware damage to Eon™ that will not be covered by warranty. Ensure that the power supply has a 24 VDC.

3.0.2 ComPort

Connect an RS232 cable to this port. Always use the provided USB to RS232 cable.

3.0.3 BNC Sensor Inputs

Eon™ has a built in oscillator. (Colnatec also offers an external oscillator for purchase). The cable between Eon™ and the crystal should remain as short as possible to avoid noise. The advisable maximum acceptable length for this is one (1) foot or 30 cm.

3.0.4 TC Connection

Receives temperature data.

3.0.5 Heater and RTD Input/Output

Connects to Tempe™ to control heating element.

3.1 Connecting Outputs

The Eon™ utilizes two (2) outputs. Make sure the correct hardware is used with these outputs.

3.1.1 DB9 Connector

Connects the 0-5 VDC output for the deposition source, the 24 VDC Mirage™, and the relay control.

3.1.2 DB15 Connector

Connects Eon™ to Tempe™ heater and RTD; used to control the Tempe™ temperature.

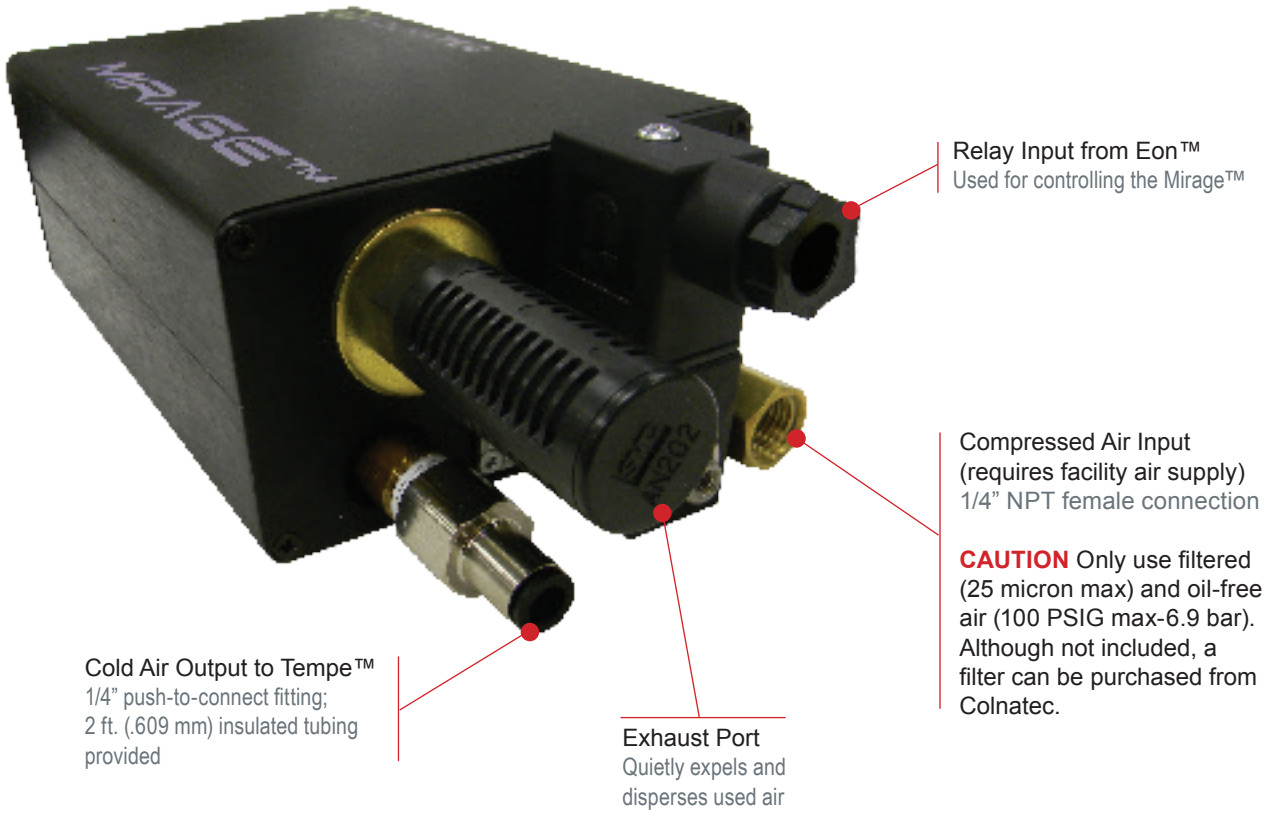


Figure I: Mirage™ Connections

3.2 Mirage™ Air-Cooling System

The Tempe™ employs a unique cooling device called the Mirage™ Air-Cooling System that connects through the DB-9 port. The Mirage™ forces cold air into the Tempe™ to counterbalance heat. Pitting hot against cold in this way provides a control mechanism for maintaining a precise temperature on the crystal surface (see Figure F).

3.3 Operating Mirage™

In order to achieve and maintain a specific target temperature on the crystal, the Tempe™ first heats the crystal to the temperature set in the deposition control menu of the Eon™ GUI. If the Tempe™ exceeds the desired temperature, the Mirage™ is triggered, blasting the crystal compartment with cold air and returning the crystal surface to the desired temperature. This type of regulated, hot-to-cold ratio control mechanism is capable of sustaining a tolerance of +/-1° C.

Because it is triggered by a simple relay input, the Mirage™ can be used as a cooling device in other applications.

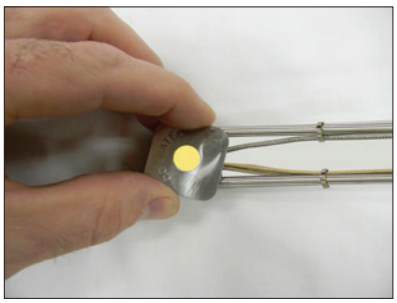
4.0 Preparing Tempe™ for Chamber

4.0.1 Inspect Tempe™

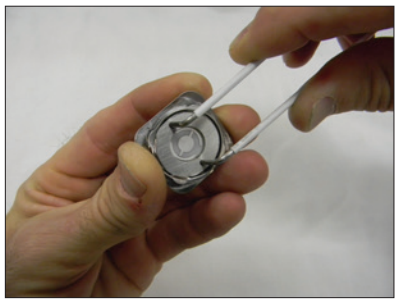
Inspect sensor head for any signs of damage that may have occurred during transport.

4.0.2 Removing Dummy Crystal

1. Turn cap clockwise to loosen. Remove cap.



2. Fit prongs of crystal tool (included) into opposing dimples on retainer ring. Turn CLOCKWISE to remove retainer ring and access crystal.

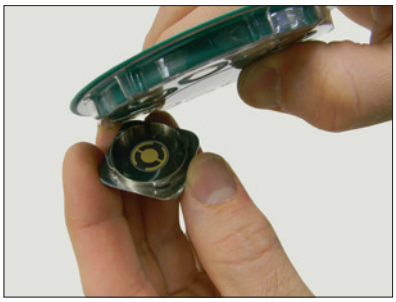


4.0.3 Adding New Crystal

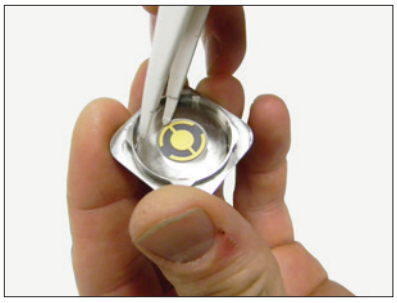
1. Rotate crystal carousel until the round opening appears above an available crystal.

2. Place rear of sensor head against the opening.

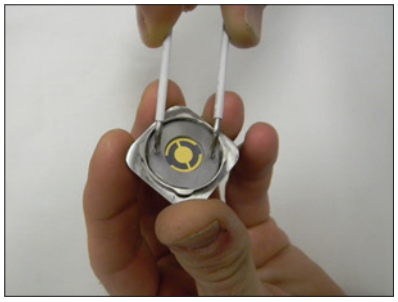
3. Allow crystal to drop into sensor head housing.



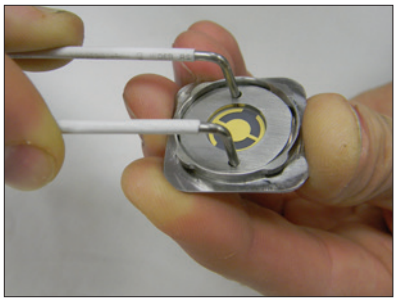
4. Use a pair of plastic tweezers to adjust crystal position until crystal rests snugly in the crystal seat.



5. Using crystal tool, fit sensor head retainer ring into place. Make sure that engraved side is up and that the flattened sides correspond to ramp locks on the inner walls of sensor head housing.



6. Rotate retainer ring counter-clockwise to tighten.



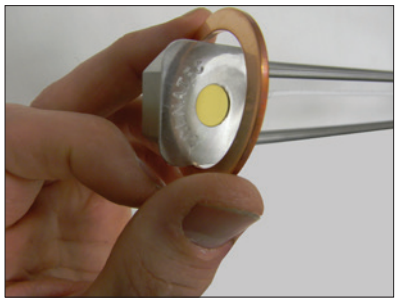
WARNING Always place retaining ring into sensor head engraved- side-up. Doing otherwise may render sensor head inoperative and crystal unsecured. An unsecured crystal may separate from sensor head and fall into chamber.

To release retainer ring, turn clockwise; to secure, turn counter-clockwise. Doing otherwise may result in hardware and equipment damage.

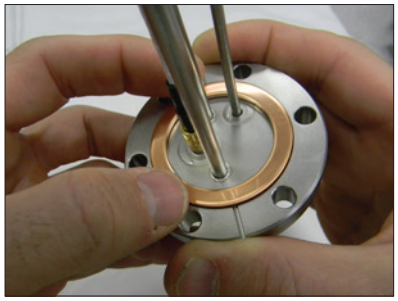
4.1 Installing Tempe™ in Chamber

4.1.1 Positioning Copper Gasket

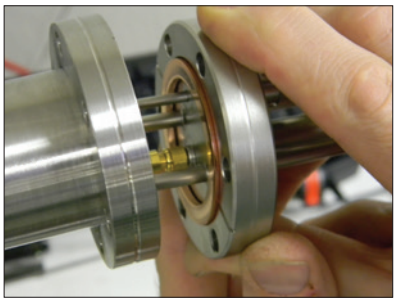
1. Remove copper gasket from packaging and thread onto sensor head.



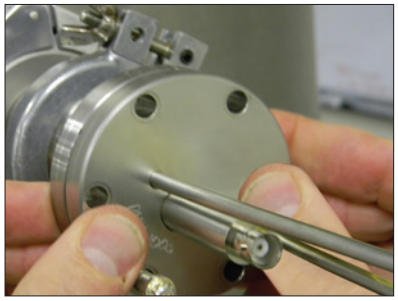
2. Fit gasket into circular groove on conflat.



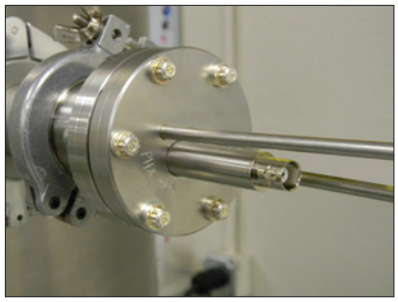
3. Hold copper gasket in place while inserting sensor head into chamber feedthrough.



4a. Press sensor head and feedthrough flanges together. Align bolt holes. Apply bolts and plate-nuts.

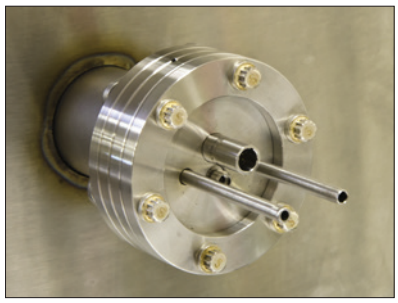


6. Rotate retainer ring counter-clockwise to tighten.



4.1.2 Access to Base Connections

Once the bolt ring has been tightened into place, there should be open access to all of the base connections on the Tempe™. (See Figure X for a complete list of all base connections and their purpose).

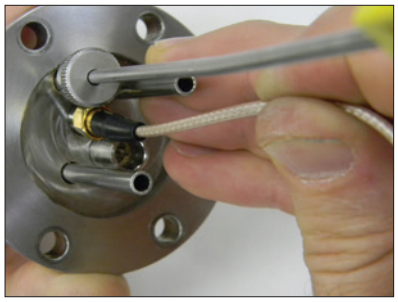


WARNING Hand-tighten flange bolts before using wrench, alternating among bolts and using a sequential torque pattern.

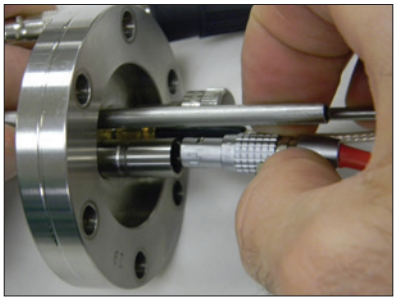
Over-tightening flange bolts may cause microfractures to develop in copper gasket. Seal may become weakened, resulting in chamber leakage.

4.2 Connecting to Tempe™

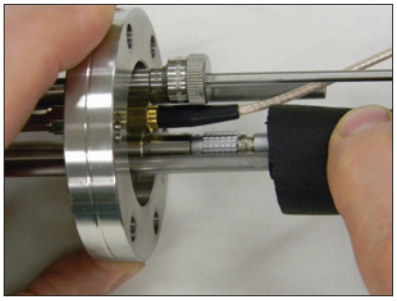
1. **BNC Coaxial Cable to Tempe™**
   Spin cable in place using cable shaft until resistance is felt. (Twisting cable shaft past point of resistance may damage cable). Roll fingertip over connector to tighten.



2. **Heater Control Cable to Tempe™**
   The 4-pin LEMO connector provides heater control and RTD measurement. To install, push until it clicks in place. The other end is a DB-15 that connects to the DB-15 heater port on the Eon™ deposition controller.



3. **Mirage™ Cooling Line to Tempe™**
   The cooling line is connected to the Mirage™ via an insulated cooling tube. Slide “push-to-connect” fitting onto the 3/16” cooling pipe projecting from the Tempe™ flange. Featuring an interior detent, cooling tube will snap securely in place.



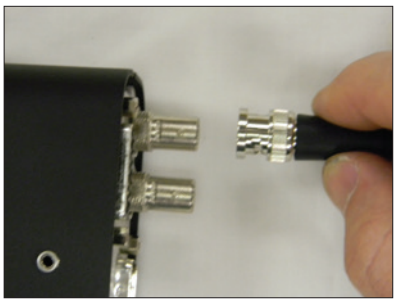
WARNING Misaligned coupling of LEMO connectors can result in severe damage to Tempe™.

Length between the Tempe™ crystal compartment and the Eon™ should NOT exceed 30 inches (76 cm) to avoid erratic noise levels in oscillation reading.

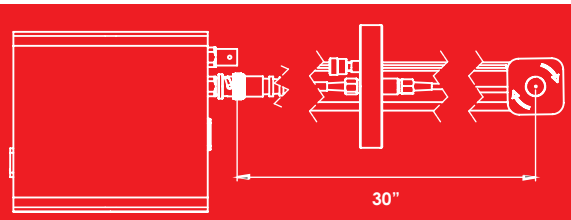
5.0 Connecting Tempe™ to Eon™

The following is a guideline on how to connect the hardware in order to prevent damage to the equipment.

1. **BNC Coaxial Cable to Eon™**
   Slide coaxial connector onto BNC Sensor Input 2.



2. **Heater Control Cable (DB-15 Connector) to Eon™**
   Plug DB-15 connector into the Eon™ 15-pin male heater port.



In order to avoid erratic noise levels in oscillation reading, length between the Phoenix™ crystal compartment and the Eon-LT™ SHOULD NOT exceed 30 inches (76.2 cm)

WARNING The cable between Eon™ and the crystal should remain as short as possible to avoid noise. The advisable maximum acceptable length for the cable is one (1) foot (30 cm).

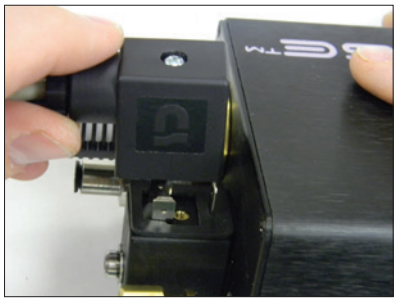
WARNING DO NOT allow operating temperature to exceed 500°C. Equipment damage will likely result.

5.1 Connecting Hardware and Electronics

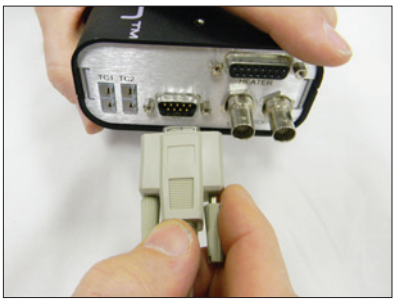
1. **Cold Air Output from Mirage™ to Tempe™**
   Slide the 3/16” tube onto the “push- to-connect” fitting on rear of the Mirage™ Cooling System. The Mirage™ provides a maximum output of 28˚C (50˚F) below the compressed air source.

2. **Compressed Air Input to Mirage™**
   Connect the Mirage™ to a filtered and oil-free compressed air source. (Air fittings may vary by country but require a 1/4 NPT female connection.

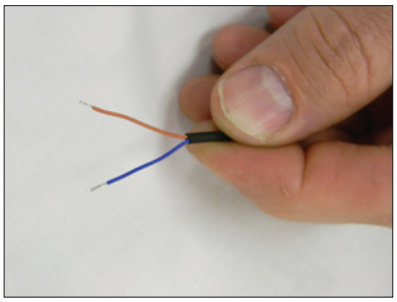
3. **Eon™ Supplies Power to Mirage™ through Power Module**
   The 3-pin solenoid module provides power to Mirage™. Tighten integrated screw after mating to Mirage™. The DB-9 connector on other end attaches to male I/O port on Eon™.



4. **Connect Mirage™ Cable to Eon™**
   Connect 9-pin female-side of Mirage™ cable to Eon™ I/O port.



5. **Relay Cable from Eon™ to Mirage™**
   Part of the DB-9 connector cable bundle that plugs into the Eon™ I/O port and relay provides a 2-wire interface for switching.



5.2 Mirage™ Features

The Mirage™ contains several key features that, alone, make the Mirage™ a singular technological achievement.

Refrigerant-Free Air Cooling

Not only maintenance free and environmentally safe, but when using regulated air the Mirage™ is easily capable of holding the sensor to a tolerance of +/-1°C.

Helps Tempe™ Maintains Temperatures up to 500°C

The Mirage™ produces a temperature output capability of 28°C (50°F) BELOW the supply air temperature, allowing the Tempe™ sensor head to maintain any temperature within 50-500°C.

Quiet Operation

While the cold air output is connected to the Tempe™ sensor head through a cooling line, the Mirage™ reduces noise by muffling and dispersing the hot air output.

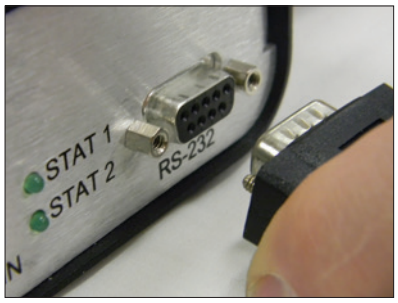
Versatility of Application

Working from a simple relay input, the Mirage™ can be used as a cooling device in alternative applications.

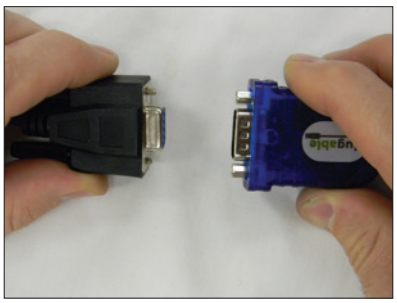
5.3 Connecting Eon™ to PC

1. **Install Eon™ Software onto PC**
   Insert the accompanying Eon™ software CD into disc drive. Follow prompts to install software onto PC.

2. **RS-232 to Eon™**
   Plug RS-232 connector into female serial port on rear panel. Tighten integrated screws.



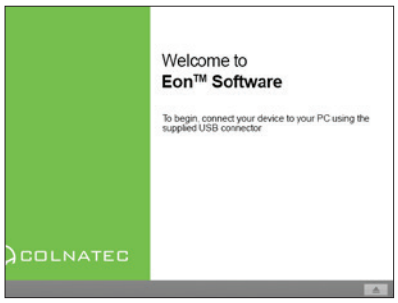
3. **RS-232 cable to USB Adapter**
   Plug the other end of the RS-232 cable into the USB-to-RS-232 adapter. Tighten integrated screws.



4. **Plug USB-to-RS-232 Adapter into PC**
   Plug USB-end of the USB-to-RS-232 adapter into PC.

5. **Connect Power to Eon™**
   Plug Eon™ power adapter into AC outlet. Then plug DC connector into the Eon™.

6. **Start Eon™ Software**
   Start Eon™ software and follow the First Start setup procedure described in the Eon™ User Manual (available on the Eon™ software CD).



WARNING If drivers are already installed, simply update the drivers when installing software.

Use only the provided USB cable.

Ensure that the software has been fully installed before connecting the USB drivers.

Fully reboot the computer after the software installation to prevent drivers issues.

Table 1 - Troubleshooting

Symptom	Cause	Solution
Broken Crystals	Crystal not seated properly.	Make sure that the crystal is seated properly in the cap and retainer to avoid mechanical stress on the crystal when temperature rise.
Weak Crystal Reading	Contact spring may have become bent.	If the crystal contact spring has become bent, it may no longer apply even pressure against the crystal. Assuring the conical spring is concentric with the body may resolve this issue.
Insufficient Heat Conduction	The heater's ceramic insulators may have become dislodged.	Often the heater's ceramic insulators become dislodged if the heater has been vigorously tugged on. This will be apparent if the heater no longer compresses or sticks when pushed down, resulting in an insufficient contact to conduct heat to the retainer. Gently wiggling the heater back and forth can sometimes resolve this issue. Servicing may be required.
Cap Will Not Screw In	The heater leads may be bent.	Bent heater leads may be preventing the cap from centering. **Do not force the cap if it will not screw in**. Re-centering the heater in the head may resolve this issue.
Software Issues	Various possible causes.	See Eon™ Controller manual for software troubleshooting guide.
Innaccurate Temperature Readings	RTD pins may be faulty	See *Advanced Troubleshooting* in Section 6.1 (Page 20) for possible solutions to these issue.
Heater Unresponsive	Heater pins may be faulty	

Because it is a scientific instrument, the Tempe™ sensor head should be treated with care. In the event of any difficulties please contact Colnatec's Customer Support. Excessive tinkering or fiddling may result in greater damage to the unit. If you cannot resolve an issue, please contact **support@colnatec.com**, or call **(480) 634-1449**.

WARNING Do not attempt to repair electrical problems. Tampering with the Tempe™ electrical systems may result in electrical fire, increased interference in crystal measurement, and damaged ceramic insulators.

6.1 Advanced Troubleshooting

6.1.1 Determining if Tempe™ RTD is faulty

1. Measure the resistance between pin A and B.

   Expected Values @ ~25C

   RTD resistance between pin A and B: 60-80Ω

6.1.2 Determining if Tempe™ heater is faulty

1. Measure the resistance between pin C and D.

   Expected Values @ ~25C

   RTD resistance between pin C and D: 4-6Ω

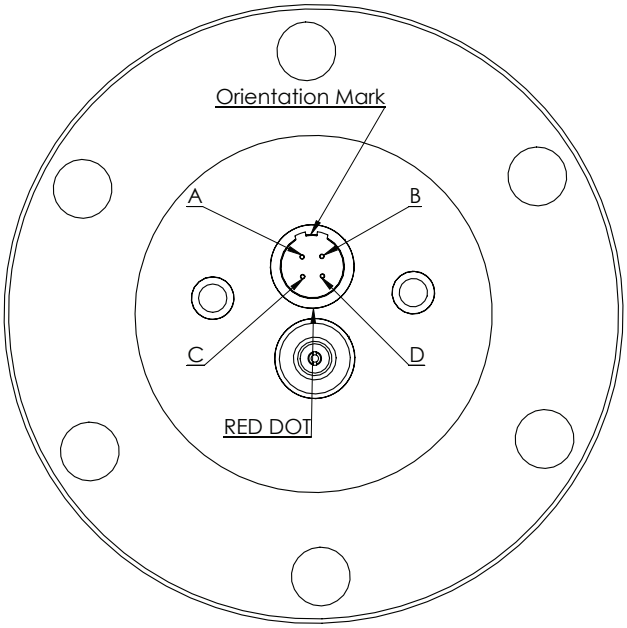


Figure J: Mirage™ Connections

7.0 Hardware

Table 2 - Hardware

Flange Size	KF40, KF50, CF275
Head Orientation	180° Concentric
Sensor Length	(designed to specification)
Cooling Tube	3/16 Diameter
Component Materials	Sensor Body 304 SS, alumina insulators, nickel alloy contact springs, 304 SS screws
	Heater Aluminum nitride heater with tungsten traces
	Type K Thermocouple 304 SS Sheath, .125”
	Crystal Cable Stainless steel-covered high-temp wire; nickel plated copper wire conductor
	Internal Heater Power Cable High-temp wire; nickel-plated copper wire conductor
Dimensions (See Figure F [pg. 4] for rendering)	Length 4” to 32” depending on customer requirements
	Cross Section Able to be passed through a 2.75” ConFlat port
Operating Temperature	40-500º C
Vacuum Rating	1x10-5 Torr
Material	AIS304 SS
Part Number	CNT-TMP-2000 Rev. 3.1 (B)

7.1 Electronics

Table 3 - Electronics

Temperature Range	0-500°C
Heater	24 [VDC] 5 [Amp]
Heater/RTD Connection	4-pin LEMO
Crystal	Standard 14 [mm]
Frequency Measurement Connection	SMA Coaxial

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