

Thermocouples Coated to Survive Longer

Introducing the best defense ever...



EtchDefender™
TECHNOLOGY

Quartz TCs for ASM Epi with EtchDefender™ coating last up to 3X longer

Thermocouples for
ASM Epsilon® Reactors
and **Diffusion Furnaces**



Ideas. Solutions. Success.

Patented EtchDefender™ coating



Up to 3X longer life and savings of 35%-45%

Conax introduces EtchDefender™—the patented solution for extending the life of quartz thermocouple sheaths.

EtchDefender™ is a quartz coating technology that can triple the life of the quartz sheath and provide savings of 35% to 45%.

Conax's cutting-edge technology has been tested both in the laboratory and in a production environment at a major wafer manufacturing facility.



EtchDefender™ advantages

Laboratory and production testing have shown:

- **No particulation**—EtchDefender™ coating is well adhered and will not flake from the quartz substrate, which causes particle contamination to the wafer.
- **Durability**—The coating does not decompose, out-gas or sublimate under vacuum at high temperature.
- **Slower devitrification**—The coating greatly slows the devitrification process typical of quartz sheaths used in the Epsilon by retarding the loss of oxygen from the SiO₂ quartz sheath at temperatures more than 900C.
- **Slower erosion**—The coating greatly retards the erosion process caused by hot corrosive gases flowing at high concentrations and velocities. This is most relevant in extending the life of the Center Thermocouple.
- **Longer life**—The coating will allow quartz sheaths to last up to three times longer.

Greater productivity and consistency

Allowing a tool to run continuously with no maintenance cycles required to change thermocouples will not only allow for increased process uptime but will reduce process variation, allowing more wafers to be produced per tool with higher consistency.

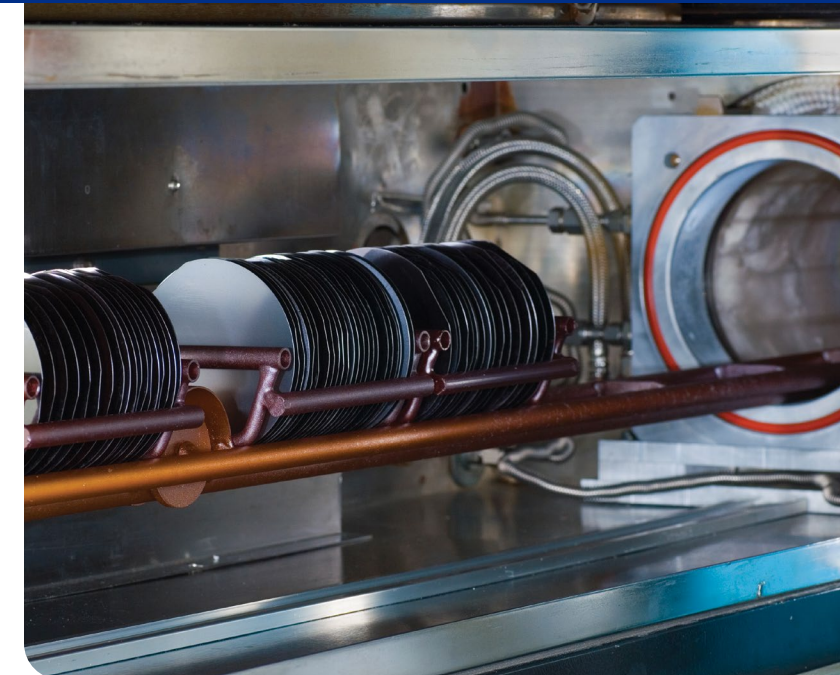
Using TCs coated with EtchDefender™ will result in reduced labor and increased safety. In addition, by reducing invasive chamber maintenance, Conax EtchDefender™ helps decrease the risk of technicians igniting pyrophoric deposits.

Reduced maintenance cycles in the SiGe process also decrease the number of times the chamber is exposed to oxygen and the time needed to totally purge the oxygen from all surfaces.

ASM Epsilon single-wafer Epi Tool

The epitaxial process takes place at one of the highest temperatures of any in the manufacture of integrated circuits. Because the ASM Epsilon single-wafer epitaxial tool uniquely utilizes thermocouples that are installed inside the reactor chamber for process control, the thermocouples are often exposed to two temperature cycles that can range from 600C to 1200C for each wafer processed.

The second temperature cycle is the etch process, which is used to clean the chamber and all the internal components with hydrochloric acid at extremely high temperatures. As thermocouples are subjected to these cycles and corrosive hydrochloric acid etches, the quartz sheath is attacked and ultimately fails, requiring a maintenance cycle to replace them.



The etch process is critical to the proper operation of the tool and maximizes yield by minimizing wafer-to-wafer contamination. If the tool is under-etched, particle generation occurs and wafer yield will drop. If the tool is over-etched, quartzware attack is greatly accelerated which causes premature failure of the quartz thermocouple sheaths, causing wafer loss and non-scheduled tool maintenance.

Our goal was to develop a solution that protects the quartz sheath during the etch process and slows devitrification to extend its life, increasing uptime and decreasing maintenance cycles. Our complete line of thermocouples for ASM Epsilon Reactors is now available with EtchDefender™ coating.

Thermocouple coated with EtchDefender™ versus standard TC



Uncoated quartz TC sheath at end of life.



EtchDefender™ Technology coated quartz sheath at 50% more wafers than TC shown on left. This sensor is currently at the mid-point of its useful life.



Thermocouples for ASM Epsilon® Reactors

Conax manufactures sensors using the best available materials, cleanest assembly cell and the finest workmanship in the industry.

Best available materials

- **Pt and Pt/Rh wires** are manufactured from mined ores— not manufactured from recycled materials.
- **Quartzware** is exclusively semiconductor grade with three available levels of quality.
- **Insulators** are of 99.5% purity or better, and are fired to remove organic impurities.
- **Connectors** are laser engraved with serial numbers (see photo above right).

Quality craftsmanship

- Conax is ISO 9001:2008 and AS9100C certified, and experienced and certified assemblers are used for every operation.
- Electronic process flow, work instructions and revision control ensure manufacturing integrity.
- Rigorous testing is performed at all assembly steps.
- Precision laser welding is used to microscopically weld and immediately inspect the quality of every junction. The process minimizes HAZ (Heat Affected Zone) damage to the very small diameter wires and junctions used within the product line.
- Each junction is again microscopically inspected after welding to ensure no damage was done to the wire as the junction was positioned against the insulator. A microscopic photograph of each junction is taken before and after it is properly positioned for quality control documentation purposes.



Cleanest assembly cell

- Our state-of-the-art ASM thermocouple assembly area is kept separate from the general production area and incorporates key clean room standards that minimize airborne particles.
- Each assembler works on a laminar flow table that provides a Class 100 clean room environment.
- All drawings and work instructions are electronic to eliminate particle generation and contamination from paper documents and to ensure that units are produced only to the latest revision of documents.
- Assemblers are outfitted in clean room apparel, gloves and magnifying goggles.



1 Laser-engraved connector.

2 Precision laser welding process.

3 Extensive testing of quartz sheaths ensures correct size, shape and quality standards.

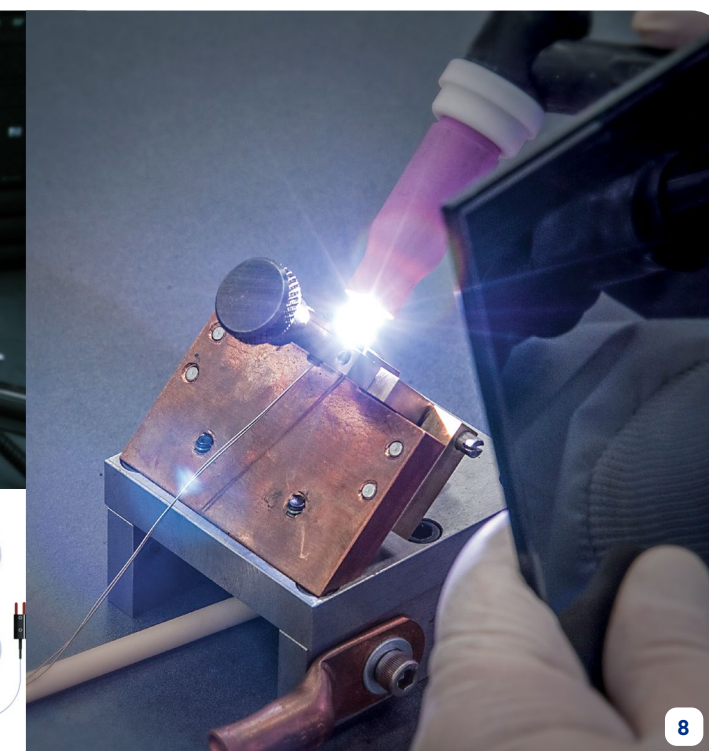
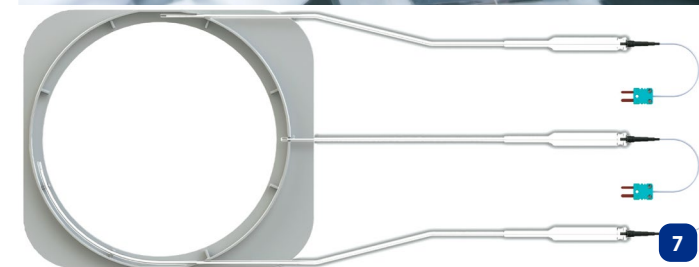
4 Profile Thermocouple assembly laminar flow tables and sensor calibration area.

5 Application of ultraviolet cured epoxy.

6 Microscopic inspection is performed following welding.

7 Top view of 200mm susceptor ring showing Front, Side and Rear thermocouples in place.

8 TIG welding used for larger diameter wires in Profile and Spike Thermocouples.



Superior performance

The two critical performance measurements used to evaluate temperature sensors are runtime longevity and lower cost of ownership. Conax provides you with both.

Runtime longevity

Our high quality products alone are proven to provide runtimes that exceed the OEM and aftermarket producers. Now, with the addition of EtchDefender™ coating, Conax thermocouples can extend the life of the quartz sheaths by up to three times.

Our objective is to design and produce sensors that are so well made that they do not fail before scheduled PMs occur. We don't want you to have to take a reactor out of production simply because you need to change a thermocouple.

By selecting the EtchDefender™ coating for your process (see chart on page 10), you can count on TCs lasting beyond the next limiting factor (most often, susceptor life). This reduces the number of times your process chamber must be opened, delivering increased safety and savings of time and money.

This will improve wafer quality and yield with:

- Less moisture in the process chamber and exhaust system minimizing residue explosion potential.
- Reduced particle generation and wafer contamination that increase yield.
- Increased number of wafers produced per thermocouple to decrease cost of ownership.
- Fewer maintenance hours spent per reactor per wafer increasing profit.

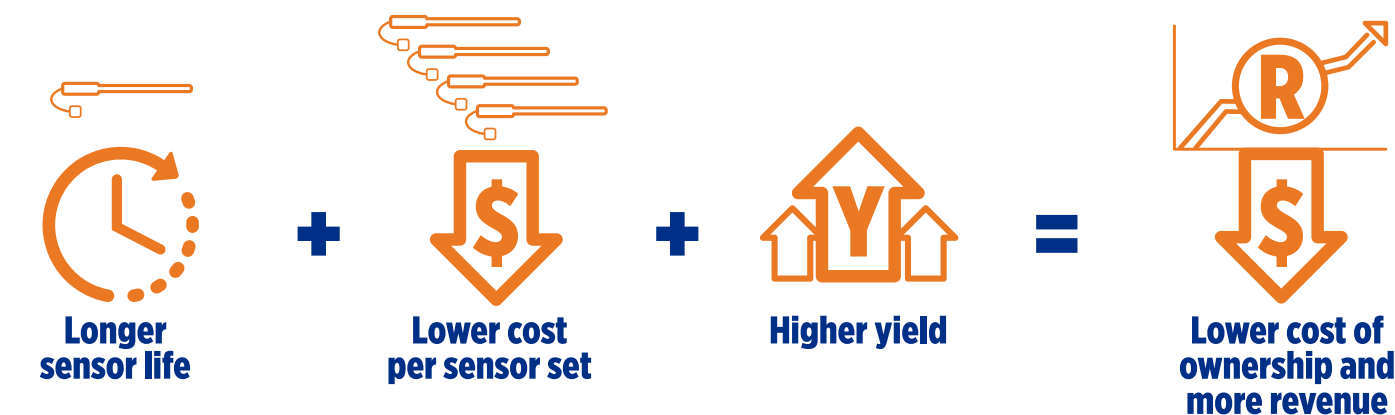
When we build products with different configurations (e.g., our new EtchDefender™ coating, thicker sheaths, and thinner wire), our product improvements are in the 160-700% range. This is particularly true when we can customize your products to include the improvements you need to optimize your specific processes.



Lower cost of ownership per reactor—two ways

Clearly a sensor set that lasts longer translates into a lower cost of ownership—and can reduce by 50% or more the number of PMs required solely to change our thermocouples. This has translated into a \$1 million annual revenue increase of end product for one Conax customer.

Another important way Conax can reduce your cost of ownership significantly is by designing robust products into one or two key sensors that serve in challenging locations within the reactor (e.g., center and front) while using less robust, less costly designs for other locations. We have participated in cost reduction programs in the 20-40% range throughout the fab, which in some cases translates into several hundreds of thousands of dollars in savings.



Customized solutions

Conax will customize designs and configure sensor sets that optimize your specific performance objectives.

We understand that one or two product designs provided by the OEM and other suppliers are simply not enough to satisfy your specific performance objectives. Every customer is different and their needs are unique. We work with each customer as a partner and strive to meet their demands for continuous performance improvements.

We can add performance improvements by optimizing temperature sensor designs within those processes. For instance, sensors serving in more demanding environments (e.g., centers) should be constructed as robustly as possible. While others within the susceptor may not be exposed to the same environmental challenges. Therefore a less robust and less costly design is sufficient.

Conax will work with you to design sensors that are ideally suited for your processes, and we can produce them for any design variability that you need:

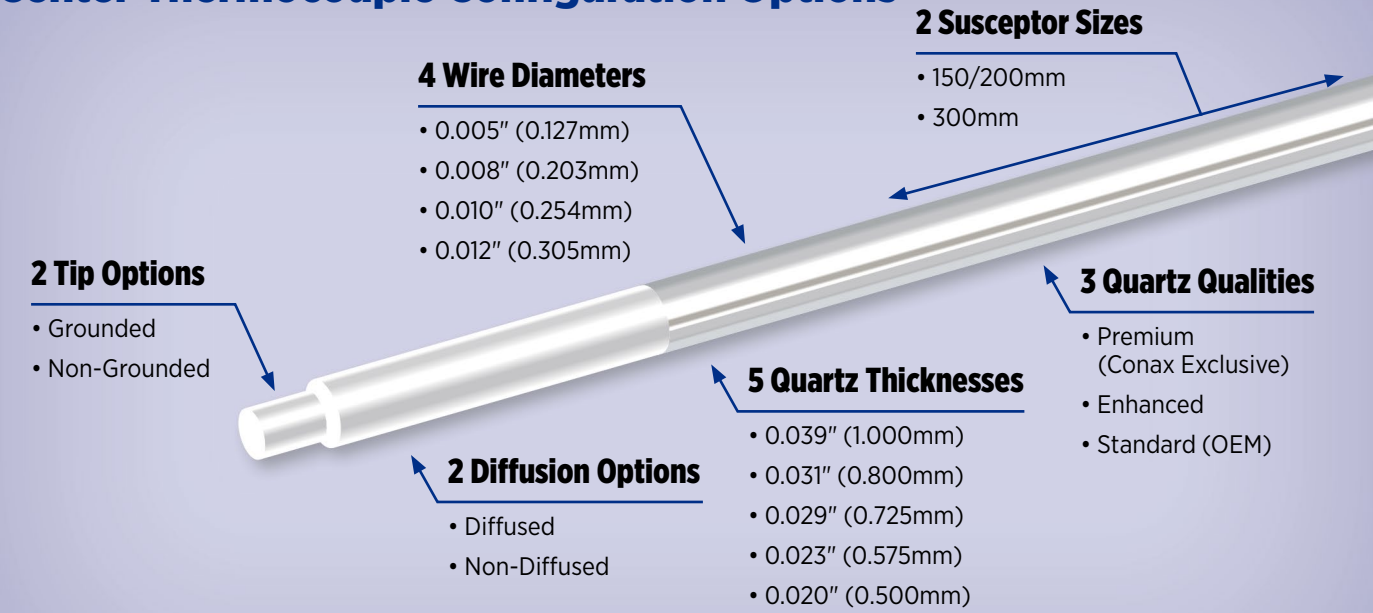
- NEW—EtchDefender™ quartz sheath coating—up to 3X longer life
- Thick wire—thick quartz
- Thick wire—thin quartz
- Thin wire—thick quartz
- Diffused or clear sheaths
- Center sensors with non-diffused, long life tips



To start the selection process, our sales engineers will work with you to help determine the various set configurations you want and will consult with our product engineers as needed, depending on the degree of customization you require.

The following pages show you how to specify the configuration solutions you need for your production objectives.

Center Thermocouple Configuration Options



Specifying your sensors

We start specifying our sensors using a base configuration model comprised of selecting one of SEVEN QUARTZ SHEATH THICKNESS OPTIONS and one of FOUR WIRE DIAMETER OPTIONS creating the possibility of TWENTY-EIGHT BASE CONFIGURATION MODELS.

Quartz Sheath Thicknesses	Wire Diameters
Series 59: 0.059" (1.500mm)	Variation 05: 0.005" (.127mm)
Series 49: 0.049" (1.250mm)	Variation 08: 0.008" (.203mm)
Series 39: 0.039" (1.000mm)	Variation 10: 0.010" (.254mm)
Series 31: 0.031" (.800mm)	Variation 12: 0.012" (.305mm)
Series 29: 0.029" (0.725mm)	
Series 23: 0.023" (0.575mm)	
Series 20: 0.020" (0.500mm)	

Customize your sensors with the features you need

From there, you can add customized features to each of your sensor types—Center, Side, Rear, Front or Bijunction. Customized features include:

- Our patented EtchDefender™ coating
- Three quality grades of quartz sheaths—OEM Standard (S), Conax Enhanced (E) and Conax Premium (P)
- Center TC tip options—grounded or non-grounded
- Diffusion options—non-diffused or diffused
- Packing—standard or special
- Other optional features (consult factory)

Customizing your design

We can design a sensor set that is the same as any sensor on the market—particularly the OEM equivalent products. If you want additional performance improvements, we offer a variety of customization possibilities.

Standard Product Features

- 150mm, 200mm and 300mm thermocouples are available
- Type R thermocouple wire
- Sheaths are manufactured from semiconductor-grade quartz tubing
- Laser engraved serial numbers are easy to read and used for material and build traceability



Custom Design Idea #1

Make the Center TC as robust as possible—and make all other sensors as economical as possible.

Failure rates are highest in the Center sensors and lower for other positions. Configure your sensor set by selecting the best features for the Center sensor and save money on the other three.

Design the Center TC with the thickest quartz with EtchDefender™ coating and the highest quality sheath. Add the largest cross sectional wire possible (e.g., base configuration model AE-150/200CR-3110P-G0D0-E3.) Then specify the standard OEM design for the other three sensors or consider incorporating a smaller diameter wire version of the standard OEM design for the other thermocouples, such as an AE-200S-2908S, etc.

Custom Design Idea #2

Fine tune each sensor according to the specific performance objectives and production recipe you require.

If a production run requires certain product attributes (see prior page), Conax can produce those sensors without having to sell them as a bundled sensor set. For instance, if running a silicon germanium wafer process requires a different recipe than a silicon wafer process, which in turn produces different temperatures and environments within the chamber, we can design a sensor configuration for those differences that minimizes your TC set cost while maximizing your yield and efficiency.

Custom Design Idea #3

Experiment with a variety of designs for each wafer process in order to optimize performance.

Conax can provide you with hundreds of configuration possibilities. The Conax Product Selection chart on the following page shows all the possible base model configurations—and those items that we have in stock.

Conax product description template

	Specify Product Line	Specify Susceptor Ring Size	Specify Susceptor Location	Specify Quartz Thickness (see chart)	Specify Quartz Diameter (see chart)		
For Center	AE = ASM Epsilon	150/200 = 150mm or 200mm 300 = 300mm	CR = Center Reduced Pressure CA = Center Atmospheric	39 = 0.039" (1.000mm) 31 = 0.031" (.800mm) 29 = 0.029" (0.725mm) 23 = 0.023" (0.575mm) 20 = 0.020" (0.500mm)	05 = 0.005" (.127mm) 08 = 0.008" (.203mm) 10 = 0.010" (.254mm) 12 = 0.012" (.305mm)		
	Specify Quartz Quality	Specify Tip Configuration	Specify Diffusion Option	Specify Special Options			
	P = Premium E = Enhanced S = Standard	G0 = Non-Grounded G1 = Grounded	D0 = Non-Diffused D1 = Diffused	E3 = EtchDefender™ coating Other options—consult factory			
For Side, Rear, Front or Bijunction	Specify Product Line	Specify Wafer Size	Specify Susceptor Location	Specify Quartz Thickness (see chart)	Specify Quartz Diameter (see chart)	Specify Quartz Quality	Specify Special Options
	AE = ASM Epsilon	150 = 150mm 200 = 200mm 300 = 300mm	F = Front R = Rear S = Side B = Bijunction	59 = 0.059" (1.500mm) 49 = 0.049" (1.250mm) 39 = 0.039" (1.000mm) 31 = 0.031" (.800mm) 29 = 0.029" (0.725mm)	05 = 0.005" (.127mm) 08 = 0.008" (.203mm) 10 = 0.010" (.254mm) 12 = 0.012" (.305mm)	P = Premium E = Enhanced S = Standard	EtchDefender™ coating (consult factory)
Center Examples	OEM Equivalent	AE - 150/200CR - 2310S - D1G1	For those seeking an OEM equivalent sensor.				
	Conax	AE - 150/200CR - 3908E - D1G1	For those seeking a superior sensor solution where a thicker quartz sheath is an advantage and wire life is typically not an issue.				
	Conax	AE-150/200CR-3110P-D0G0 - E3	For those seeking the ultimate quartz life where EtchDefender™ coating plus a thicker/better quartz and robust wire size provides the potential for using a single thermocouple up to 3x longer.				
Front, Side, Rear or Bijunction Examples	OEM Equivalent	AE - 300B - 3910S	For those seeking an OEM equivalent sensor.				
	Conax	AE - 300B - 4908P	For those seeking a superior sensor solution where a thicker quartz sheath is an advantage and wire life is typically not an issue.				
	Conax	AE - 300B - 4910P - E3	For those seeking the ultimate quartz life where EtchDefender™ coating plus a thicker/better quartz and robust wire size provides the potential for using a single thermocouple up to 3x longer.				



Product Selection Chart—Conax Thermocouples for the ASM Epsilon Reactors

This product chart illustrates several things. The chart shows all base configuration models that Conax can produce with the exception of the grey cells.

Susceptor Ring Size	Series	Center Thermocouples			
		Wire Diameter			
		Variation 05 DIA = .005" (.127mm)	Variation 08 DIA = .008" (.203mm)	Variation 10 DIA = .010" (.254mm)	Variation 12 DIA = .012" (.305mm)
150mm	Beginning Series Description	AE-150/200CR- or AE-150/200CA-			
	Series 59: 0.059" (1.500mm)				
	Series 49: 0.049" (1.250mm)		4908P-GOD0	4910P-GOD0	4912P-GOD0
	Series 39: 0.039" (1.000mm)	3905P-GOD0			
	Series 31: 0.031" (0.800mm)		3108P-GOD0	3110P-GOD0 <i>02-352105D01</i> <i>02-352105D02</i>	
	Series 29: 0.029" (0.725mm)				
	Series 23: 0.023" (0.575mm)		2308E-GID1 2308S-GID1	2310E-GID1 2310S-GID1 <i>02-321895D01</i> <i>02-323584D01</i>	2312E-GID1
Series 20: 0.020" (0.500mm)		2008P-GOD1 2008E-GOD1	2010E-GOD1 2010S-GOD1 <i>02-330816D01</i> <i>02-330816D02</i>	500mm	
200mm	Beginning Series Description	AE-150/200CR- or AE-150/200CA-			
	Series 59: 0.059" (1.500mm)				
	Series 49: 0.049" (1.250mm)		4908P-GOD0	4910P-GOD0	4912P-GOD0
	Series 39: 0.039" (1.000mm)	3905P-GOD0			
	Series 31: 0.031" (0.800mm)		3108P-GOD0	3110P-GOD0 <i>02-352105D01</i> <i>02-352105D02</i>	
	Series 29: 0.029" (0.725mm)				
	Series 23: 0.023" (0.575mm)		2308E-GID1 2308S-GID1	2310E-GID1 2310S-GID1 <i>02-321895D01</i> <i>02-323584D01</i>	2312E-GID1
Series 20: 0.020" (0.500mm)		2008E-GOD1 2008S-GOD1	2010E-GOD1 2010S-GOD1 <i>02-330816D01</i> <i>02-330816D02</i>		
300mm	Beginning Series Description	AE-300CR-			
	Series 59: 0.059" (1.500mm)				
	Series 49: 0.049" (1.250mm)		4908P-GOD0	4910P-GOD0	
Series 39: 0.039" (1.000mm)		3908S-GOD0	3910S-GOD0 <i>02-178674D01</i> <i>02-144677-01</i>	3912S-GOD0	
2000PR	Beginning Series Description				
	Series 79: 0.079" (2.000mm)				
3000PR	Beginning Series Description				
	Series 79: 0.079" (2.000mm)				

Where Conax product series are shown in the chart, they are usually available for shipment within 1 week. To help you understand how our product series differ from the OEM, we have colored the wire/quartz size for the standard OEM product in yellow and the long life OEM series in blue. In these yellow and blue colored cells you will find the OEM part number shown in italics for your reference. Please

use this chart to customize and specify the thermocouple sets you would like to use. Special introductory pricing is available for testing and qualification sets—please ask your salesperson for details.

Bijunction Thermocouples				Front Thermocouples				Side Thermocouples				Rear Thermocouples			
Wire Diameter				Wire Diameter				Wire Diameter				Wire Diameter			
Variation 05 DIA = .005" (.127mm)	Variation 08 DIA = .008" (.203mm)	Variation 10 DIA = .010" (.254mm)	Variation 12 DIA = .012" (.305mm)	Variation 05 DIA = .005" (.127mm)	Variation 08 DIA = .008" (.203mm)	Variation 10 DIA = .010" (.254mm)	Variation 12 DIA = .012" (.305mm)	Variation 05 DIA = .005" (.127mm)	Variation 08 DIA = .008" (.203mm)	Variation 10 DIA = .010" (.254mm)	Variation 12 DIA = .012" (.305mm)	Variation 05 DIA = .005" (.127mm)	Variation 08 DIA = .008" (.203mm)	Variation 10 DIA = .010" (.254mm)	Variation 12 DIA = .012" (.305mm)
AE-150B-				AE-150F-				AE-150S-				AE-150R-			
	5908P	5910P	5912P		5908P	5910P	5912P		5908P	5910P	5912P	5905P	5908P	5910P	5912P
	4908P*	4910P* <i>02-352074D01</i>			4908P*	4910P* <i>02-352119D01</i>			4908P*	4910P* <i>02-352078D01</i>			4908P*	4910P* <i>02-352076D01</i>	
	3908P	3010P			3908P	3010P			3908P	3010P			3908E	3910E	3912E
	3908E	3910E			3908E	3910E			3908E	3910E					
	2908S	2910S <i>02-327874D01</i>			2908S	2910S <i>02-323647D01</i>			2908S	2910S <i>02-323649D01</i>			2908S	2910S <i>02-323648D01</i>	
AE-200B-				AE-200F-				AE-200S-				AE-200R-			
	5908P	5910P	5912P		5908P	5910P	5912P		5908P	5910P	5912P	5905P	5908P	5910P	5912P
	4908P*	4910P* <i>02-352066D01</i>			4908P*	4910P* <i>02-352118D01</i>			4908P*	4910P* <i>02-352072D01</i>			4908P*	4910P* <i>02-352070D01</i>	
	3908P	3910P			3908P	3910P			3908P	3910P			3908E	3910E	3912E
	3908E	3910E			3908E	3910E			3908E	3910E					
	2908S	2910S <i>02-327875D01</i>			2908S	2910S <i>02-323652D01</i>			2908S	2910S <i>02-323654D01</i>			2908S	2910S <i>02-323653D01</i>	
AE-300B-				AE-300F-				AE-300S-				AE-300R-			
	4908P*	4910P*			4908P*	4910P*			4908P*	4910P*			4908P*	4910P*	
	3908S	3910S <i>02-178704D01</i>			3908S	3910S			3908S	3910S <i>02-178706D01</i>			3908S	3910S <i>02-178705D01</i>	
Front-Side				Front-Rear				Side-Rear							
AE-2000PR-FS-				AE-2000PR-FR-				AE-2000PR-SR-							
		7910S <i>02-338332-01</i>	7912S			7910S <i>02-338455-01</i>	7912S			7910S <i>1061-542-01</i>	7912S				
AE-3000PR-FS-				AE-3000PR-FR-				AE-2000PR-SR-							
		7910S <i>1070-292-01</i>	7912S			7910S <i>1070-291-01</i>	7912S			7910S	7912S				

How to use this Product Selection Chart

Inside of each cell:

- Conax existing Series numbers shown in **bold type**
- OEM part numbers shown in *italic type*
- White, yellow, and blue shaded cell = Conax design possibilities
- Yellow shaded cell = OEM standard sheath and wire size
- Blue shaded cell = OEM long life sheath and wire size
- Orange shaded cell = Special Susceptor and Ring required
- Gray shaded cell = Not a Conax recommended design
- The majority of existing Conax part numbers are available to be shipped within one week. Some may be shipped within one day.
- Ask your Conax salesperson for assistance in using this chart.

Quartz Quality Index

- Series Number XXXXP = Premium Quality Quartz
- Series Number XXXXE = Enhanced Quality Quartz
- Series Number XXXXS = Standard Quality Quartz

EtchDefender™

Any thermocouple offered may have EtchDefender™ coating added for the ultimate quartz sheath life available. Simply add “-E3” suffix to a TC description.



For example...

- AE-200R-2910S = Standard design
- AE-200R-2910S-E3 = Standard design with EtchDefender™

Important Conax Long Life Sensor Feature vs. OEM

*The Conax sheath thickness of 1.250mm is slightly thicker than the OEM sheath thickness of 1.200mm. Some OEM long life sensors have wire(s) directly exposed to quartz, making platinum wire vulnerable to attack and causing premature calibration drift. However, Conax long life sensors have both wires isolated from each other and quartz sheath protection all the way to the measurement junction. OEM sensor part numbers are denoted by italic type.

Profile Thermocouples for Diffusion Furnaces

Conax profile thermocouples are high-precision temperature sensors standard and custom designed for the semiconductor, solar and LED industries. These thermocouples are engineered to address the critical process temperature measurement and control required for those industries.



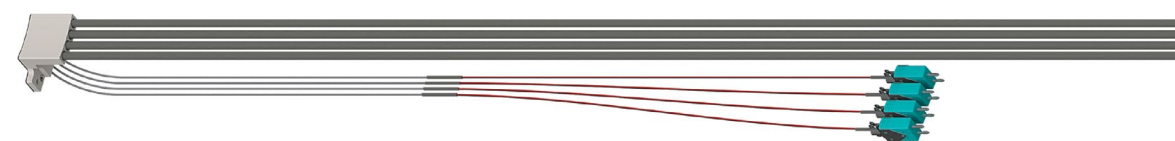
Profile Thermocouple for ASM Advance® 4XX

Conax offers Profile thermocouples for the A4XX furnace. Shown is a standard 5-zone configuration. Product design options include extra thick or removable sheaths, vacuum feedthroughs for the lead wires and abilities to customize other product features.



Profile Thermocouple for the Tokyo Electron

Conax offers Profile thermocouples for TEL furnaces such as the Alpha® series shown.



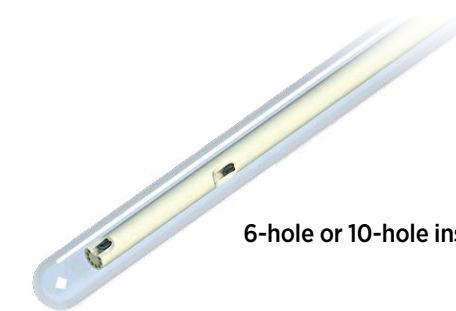
Profile Thermocouple for Hitachi Kokusai Electron

Conax offers Profile thermocouples for Kokusai furnaces such as the Vertron® series show—available with either quartz (as shown) or SiC sheaths.

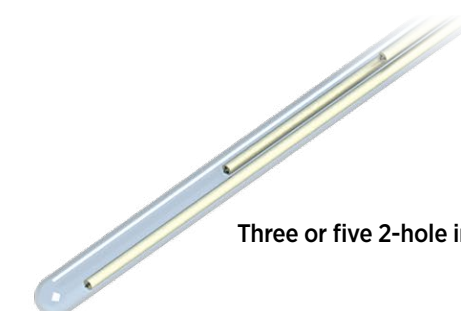
Conax offers a variety of straight sheath profile TCs primarily for horizontal furnace applications. These may be equipped with sheaths that have quartz socket connections as shown below or without. We provide replacement sheaths for processes that attack sheaths fast while the internal TC is still functioning and accurate. We also provide wire/insulator assemblies for retrofit into furnace tubes that have integral TC sheaths.



The internal thermocouples are typically supplied with a 3-zone or 5-zone configuration. The thermocouple wire can populate either a single 6-hole or 10-hole insulator. Alternatively, the wires can populate three or five 2-hole insulators.



6-hole or 10-hole insulator



Three or five 2-hole insulators

Connectorization is accommodated by standard or miniature 2-pin connectors. Multi-pin screw or bayonet-style connectors are also offered. The lead wires between the probe and the connectors run continuously using the same noble metal thermocouple wire that is installed in the quartz sheath. As a cost savings option, Conax can transition to extension grade wire for the lead wires.

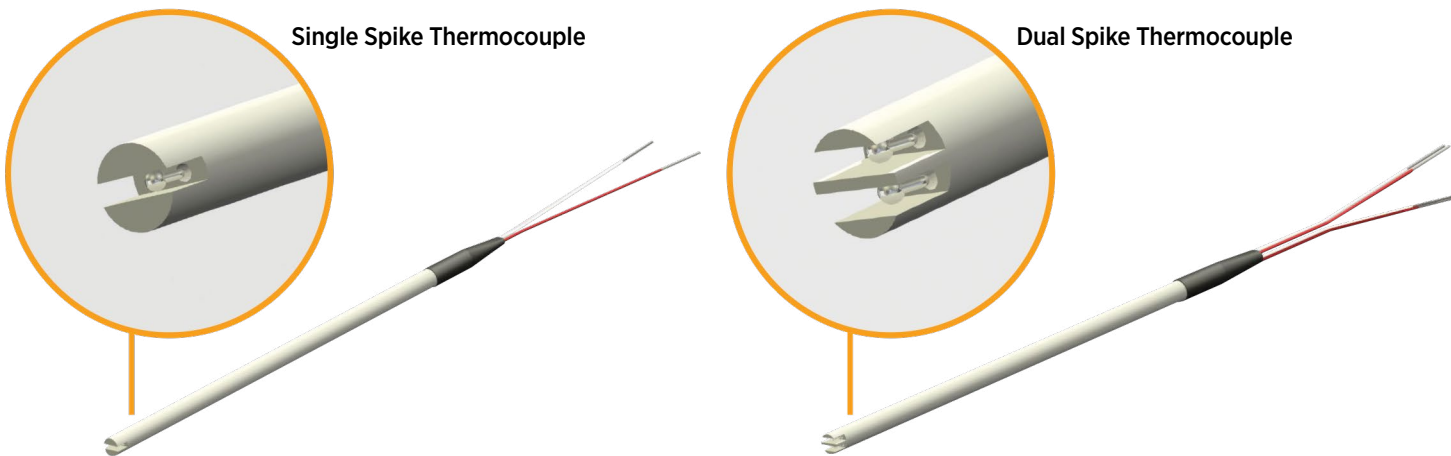


Spike Thermocouples for Diffusion Furnaces

Single Spike Thermocouples vs. Dual Spike Thermocouple.

Spike thermocouples or torch thermocouples can be ordered as single or dual (two measuring junctions). Dual spike thermocouples are often used for a redundant measurement in the event that one circuit fails. Duals may also be used to track sensor drift. This is accomplished by populating one of the dual circuits with a different calibration wire (typically R,

S, or B) than the other circuit. As the thermocouple circuits age, they will drift. Different calibrations will drift at different rates. Comparing the rate of drift differential will give an indication as to the amount of drift the particular dual spike is experiencing, and by extension, the rate of drift for the other spikes. Spike recalibration or replacement decisions may be made based on objective criterion rather than arbitrary time-based maintenance schedules.



Technician shown preparing the Automated Profile Thermocouple Calibration System for use with some sensors to be calibrated.

Profile Thermocouple Calibrations

Conax offers Profile Thermocouple calibrations at standard or customer specified temperature intervals. All calibrations are conducted under the guidance of our quality system, certified to ISO 9001:2008 and are performed by comparison techniques as defined in ASTM E220. Conax utilizes primary and secondary standard thermocouples that are traceable to NIST and state-of-the-art equipment with a custom automated process control and data acquisition system (see photo below on page 14).

Our Automated Profile TC Calibration System continuously monitors the thermocouple outputs while simultaneously controlling the temperature ramp of the furnace. This system requires that the thermocouples stabilize at each calibration temperature before data is collected, then converts the thermocouple millivolt signal to a temperature, and compares this information to the standard. The offset and acceptance to defined limits is all determined without technician intervention, thereby eliminating possible human error and providing optimal accuracy.

Profile Thermocouples offer a unique calibration challenge because of their length and the fact that multiple thermocouples are located at various positions along the length of the unit. Conax has developed a unique system which employs a specially designed 60" long calibration furnace that allows us to simultaneously calibrate up to four 5-Point Profile Thermocouples at a single time (i.e., 20 total thermocouples). The standard and calibration thermocouples reside in the same furnace tube as the units under calibration, minimizing the thermal gradient between them.

"Unit Calibration" is the individual calibration of Profile Thermocouples, as described in the previous section. Data is provided in a table format over a defined temperature range with the offsets in both degrees Celsius and millivolt format. (See the sensor calibration table [SCT] above for more details.) Unit Calibration is available upon request and is a cost added option to any profile thermocouple.

As an alternative, "Bulk Wire Calibration" is available upon request at no extra charge. Wire from each lot of material is electrically annealed, bound to the standard with platinum wire to ensure temperature uniformity and calibrated using the Automated Thermocouple Calibration System. Calibrated wire is then released for production with a Bulk Wire Calibration Certificate. Conax will provide bulk wire calibration data in the SCT format depicted above.

Temp		Offset		Temp		Offset		Temp		Offset		Temp		Offset	
°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV	°C	mV
400	-0.007	-0.73	525	-0.008	-0.85	650	-0.009	-0.87	775	-0.009	-0.85	900	-0.009	-0.78	
405	-0.007	-0.74	530	-0.008	-0.85	655	-0.009	-0.87	780	-0.009	-0.85	905	-0.009	-0.78	
410	-0.007	-0.75	535	-0.009	-0.85	660	-0.009	-0.87	785	-0.009	-0.85	910	-0.009	-0.77	
415	-0.007	-0.75	540	-0.009	-0.85	665	-0.009	-0.87	790	-0.009	-0.84	915	-0.009	-0.77	
420	-0.007	-0.76	545	-0.009	-0.86	670	-0.009	-0.87	795	-0.009	-0.84	920	-0.009	-0.77	
425	-0.007	-0.77	550	-0.009	-0.86	675	-0.009	-0.87	800	-0.009	-0.84	925	-0.009	-0.76	
430	-0.007	-0.77	555	-0.009	-0.86	680	-0.009	-0.87	805	-0.009	-0.84	930	-0.009	-0.76	
435	-0.008	-0.78	560	-0.009	-0.86	685	-0.009	-0.87	810	-0.009	-0.83	935	-0.009	-0.76	
440	-0.008	-0.78	565	-0.009	-0.86	690	-0.009	-0.87	815	-0.009	-0.83	940	-0.009	-0.75	
445	-0.008	-0.79	570	-0.009	-0.86	695	-0.009	-0.87	820	-0.009	-0.83	945	-0.009	-0.75	
450	-0.008	-0.79	575	-0.009	-0.87	700	-0.009	-0.87	825	-0.009	-0.83	950	-0.009	-0.75	
455	-0.008	-0.80	580	-0.009	-0.87	705	-0.009	-0.87	830	-0.009	-0.82	955	-0.009	-0.75	
460	-0.008	-0.80	585	-0.009	-0.87	710	-0.009	-0.87	835	-0.009	-0.82	960	-0.009	-0.74	
465	-0.008	-0.81	590	-0.009	-0.87	715	-0.009	-0.87	840	-0.009	-0.82	965	-0.008	-0.74	
470	-0.008	-0.81	595	-0.009	-0.87	720	-0.009	-0.87	845	-0.009	-0.81	970	-0.008	-0.74	
475	-0.008	-0.81	600	-0.009	-0.87	725	-0.009	-0.86	850	-0.009	-0.81	975	-0.008	-0.74	
480	-0.008	-0.82	605	-0.009	-0.87	730	-0.009	-0.86	855	-0.009	-0.81	980	-0.008	-0.73	
485	-0.008	-0.82	610	-0.009	-0.87	735	-0.009	-0.86	860	-0.009	-0.81	985	-0.008	-0.73	
490	-0.008	-0.83	615	-0.009	-0.87	740	-0.009	-0.86	865	-0.009	-0.80	990	-0.008	-0.73	
495	-0.008	-0.83	620	-0.009	-0.87	745	-0.009	-0.86	870	-0.009	-0.80	995	-0.008	-0.73	
500	-0.008	-0.83	625	-0.009	-0.87	750	-0.009	-0.86	875	-0.009	-0.80	1000	-0.008	-0.72	
505	-0.008	-0.84	630	-0.009	-0.87	755	-0.009	-0.86	880	-0.009	-0.79	1005	-0.008	-0.72	
510	-0.008	-0.84	635	-0.009	-0.87	760	-0.009	-0.85	885	-0.009	-0.79	1010	-0.008	-0.72	
515	-0.008	-0.84	640	-0.009	-0.87	765	-0.009	-0.85	890	-0.009	-0.79	1015	-0.008	-0.72	
520	-0.008	-0.85	645	-0.009	-0.87	770	-0.009	-0.85	895	-0.009	-0.78	1020	-0.008	-0.72	

For each temperature reading, add the mV or temperature offset to obtain the corrected value.

This calibration data was produced under the guidelines defined in Conax Technologies' ISO 9001 Quality System and is traceable to the National Institute of Standards.

EMF and temperature values presented in this report are derived from calibration data obtained using the comparison techniques described in ASTM E220 (Standard Test Method for Calibration of Thermocouples by Comparison Techniques) coupled with interpolation techniques based on the mathematical guidelines outlined in ASTM E220.

Calibration Performed By: 25. Maziarz, Peter Date: 8/21/2012
 Report Generated By: 45. Boyce, Glenn Date: 3/25/2013

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Above is a typical Sensor Calibration Table (SCT). Starting, ending points and increments may be defined by the customer. 400C-1200C in 5C increments is standard.

How do you determine which type of calibration is right for your application? Generally, there are two issues to consider when choosing bulk wire versus unit calibration.

- Variation in the wire emf output within a single wire lot (i.e. wire inhomogeneity)
- Manufacturing induced "drift" during the handling and fabrication of the target thermocouple

Conax has analyzed both issues. Variation in the wire emf was evaluated with calibrations run using Conax wire lots at National Institute of Standards and Technology (NIST) and found that any effects due to wire inhomogeneity were insignificant relative to the NIST measurement uncertainty. Manufacturing induced "drift" was evaluated by comparing bulk wire and unit calibrations from the same wire lot and is typically minimized the first time the unit is heated. Therefore, both items have minimal contribution to the accuracy of the thermocouple and it is concluded that bulk wire calibration data can be used in the majority of applications with little or no impact on the system's accuracy. For further information to help you determine what type of calibration is right for your application, our application engineers will be happy to guide you.



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