

# Furnace Tracker<sup>®</sup>

GENERAL SYSTEM  
USER MANUAL

*for use with*

**insight**  
software

Issue 1





A Fluke Company

# Furnace Tracker®

## General System User Manual

for use with

**insight**  
software

Issue 1



*Datapaq is the world's leading manufacturer of process temperature-monitoring instrumentation. The company maintains this leadership by continual development of its advanced, easy-to-use Tracker systems.*

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# SAFETY WARNINGS

For safe use of Datapaq equipment, always:

- Take care to follow its supplied instructions.
- Observe any warning signs shown on the equipment itself.



Indicates **potential hazard**.

On Datapaq equipment this normally warns of high temperature, but where you see the symbol you should consult the manual for further explanation.



Warns of **high temperatures**.

Where this symbol appears on Datapaq equipment, the surface of the equipment may be excessively hot (or excessively cold) and may thus cause skin burns.

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# Introduction

This manual contains information on the use and maintenance of the Furnace Tracker® Thermal Barrier Systems. The chapters are arranged in logical order, explaining the Furnace Tracker system and the sequence of events in setting up and conducting a temperature profile run. Information on the use and maintenance of thermocouple probes is included.

For guidance on setting up your logger please refer to the dedicated manual supplied. For information on using the Insight™ software, please refer to the online Help system available when it is installed.

The manual contains the following sections:

**Barriers Heatsinks** – Describes the system’s thermal barriers and heatsinks and lists their specifications. Also includes care and maintenance procedures.

**Thermocouple Probes** – Describes Datapaq’s range of thermocouple probes. Also includes care and maintenance procedures.

**Running a Temperature Profile** – All the stages of obtaining a profile, including the positioning of probes.

**Recovering the System** – Removing the system from the furnace, downloading the data, and completing the documentation.

**Troubleshooting** – How to diagnose common problems.



# Barriers and Heatsinks

The **thermal barrier** provides the thermal and mechanical protection necessary for the data logger to survive in the hostile environment of an industrial furnace.

Microporous insulation covered by a Mullite fiber cloth provides the primary thermal protection. **Heatsinks** – stainless steel containers filled with a non-toxic, non-flammable phase-changing material – provide additional, secondary protection when the system has to operate at high temperature for extended periods. The phase-changing material absorbs the heat and maintains a temperature of 58°C /136°F until all the material has changed from solid to liquid state.

Heatsinks have a temperature-sensitive label to provide indication of the maximum temperature experienced by the data logger, and a warning should the temperature exceed 77°C /170°F. This warning is significant! Please refer to the Care and Maintenance section on page 15 for further information.

*The Microporous insulation material will absorb moisture if stored in a damp environment. Although this will not result in damage to the thermal barrier, its performance will be degraded until the moisture is removed.*

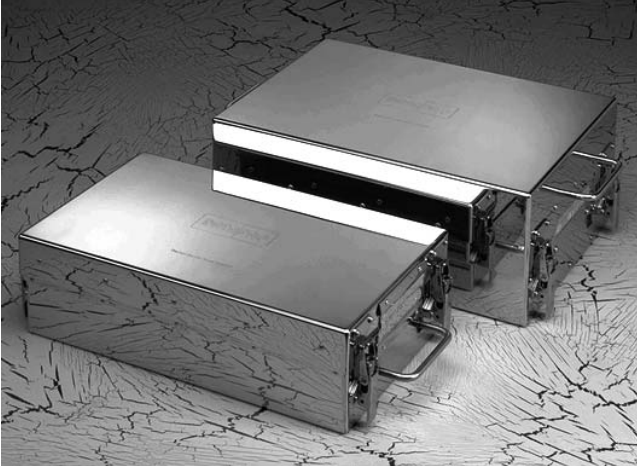
## Selecting the Thermal Barrier

The selection of barrier type depends principally on the height and width limitations of the furnace, the data logger type, process duration, temperature, time at temperature, furnace atmosphere and whether the process includes a quench cycle. Two ranges of barrier are available:

- **4000 Series standard range** – For use in environments free from carbon and where maximum temperature does not exceed 800°C/1472°F.
- **4900 Series for severe environments** – For environments where carbon is present and maximum temperatures do not exceed 1,050°C/1922°F in normal combustion atmospheres. Also recommended for applications where temperatures change rapidly (such as gas quench) as this range of barrier utilizes Datapaq's floating plate technology to minimize distortion of the thermal barrier's base and lid. Also recommended where height tolerances are critical.

When assessing the barrier's thermal-performance requirement, include the time taken to retrieve the Tracker system from the furnace, and to remove the data logger from the barrier in the overall process duration. Consult Datapaq for advice on thermal barrier selection.

## Standard TB4000 Barrier Types



TB4000 series thermal barriers.

### TB4015

<b>Temp. °C</b>	200	400	600	800
<b>Temp. °F</b>	392	752	1112	1472
<b>Duration</b>	3hrs 20mins	1hr 50mins	1hr 10mins	50mins
<b>Dimensions</b>	Height 100 mm 3.9 in.	Width 247mm 9.7 in.	Length 509mm 20 in.	Weight 9kg 19.8 lbs
<b>Logger</b>	Datapaq 9000 (DP9064)			
<b>Heatsink</b>	1 × TB1001A			

*Due to continuing product development, specifications are subject to change without notice.*

## TB4005

<b>Temp. °C</b>	200	400	600	800
<b>Temp. °F</b>	392	752	1112	1472
<b>Duration</b>	6hrs	2hrs		1hr
<b>Dimensions</b>	Height 125mm 4.9 in.	Width 248mm 9.8 in.	Length 504mm 19.8 in.	Weight 10.5kg 23.1 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (DP9064)	
<b>Heatsink</b>	1 × TB1001A		1 × TB1001A	

## TB4056

<b>Temp. °C</b>	200	400	600	800
<b>Temp. °F</b>	392	752	1112	1472
<b>Duration</b>	8hrs	4hrs 15mins	2hrs 45mins	2hrs
<b>Dimensions</b>	Height 150mm 5.9 in.	Width 275mm 10.8 in.	Length 504mm 19.8 in.	Weight 15kg 33 lbs
<b>Logger</b>	Datapaq 9000 (DP9064)		Tpaq21	
<b>Heatsink</b>	2 × TB1001A		2 × TB1001A	

## TB4012

<b>Temp. °C</b>	200	400	600	800
<b>Temp. °F</b>	392	752	1112	1472
<b>Duration</b>	15hrs 30mins	6hrs 30mins	4hrs	2hrs 6mins
<b>Dimensions</b>	Height 170mm 6.7 in.	Width 296mm 11.6 in.	Length 511mm 20.1 in.	Weight 20 kg 44 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (DP9064)	
<b>Heatsink</b>	1 × TB1066A		1 × TB1069A	

## TB4026

<b>Temp. °C</b>	200	400	600	800
<b>Temp. °F</b>	392	752	1112	1472
<b>Duration</b>	24hrs	12hrs	8hrs 30mins	6hrs
<b>Dimensions</b>	Height 250mm 9.8 in.	Width 357mm 14 in.	Length 543mm 21.4 in.	Weight 31kg 68.2 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (DP9064)	
<b>Heatsink</b>	1 × TB1066A		1 × TB1069A	

## Series 4900 Severe Environment Barriers



TB4912 severe environment thermal barrier with heatsink and Tpaq21.

### TB4915

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	3hrs 20mins	1hr 50mins	1hr 10mins	50mins	40mins
<b>Dimensions</b>	Height 104mm 4.1 in.	Width 247mm 9.7 in.	Length 409mm 16.1 in.	Length inc handles 529mm 20.8 in	Weight 9.5kg 20.9 lbs
<b>Logger</b>	Datapaq 9000 (DP9064)				
<b>Heatsink</b>	1 × TB1001A				

*Due to continuing product development, specifications are subject to change without notice.*

## TB4905

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	6hrs	2hrs	1hr 15mins	1hr	50mins
<b>Dimensions</b>	Height 129mm 5.1 in.	Width 247mm 9.7 in.	Length 409mm 16.1 in.	Length inc handles 529mm 20.8 in.	Weight 11kg 24.2 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (DP9064)		
<b>Heatsink</b>	1 × TB1001A		2 × TB1001A		

## TB4956

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	8hrs	4hrs 15mins	2hr 45mins	2hrs	1hr 15mins
<b>Dimensions</b>	Height 154mm 6.1 in.	Width 275mm 10.8 in.	Length 409mm 16.1 in.	Length inc handles 529mm 20.8 in.	Weight 15.5kg 34.1 lbs
<b>Logger</b>	Datapaq 9000 (DP9064) Tpaq21				
<b>Heatsink</b>	2 × TB1001A				

## TB4912

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	14hrs 30mins	6hrs 30mins	4hrs	2hrs 5mins	1hr 45mins
<b>Dimensions</b>	Height 174mm 6.8 in.	Width 296mm 11.6 in.	Length 411mm 16.2 in.	Length inc handles 531mm 20.9 in.	Weight 21kg 46.2 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (9064)		
<b>Heatsink</b>	1 × TB1066A		1 × TB1069A		

## TB4938

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	18hrs	9hrs	5hrs 30mins	3hrs 45mins	2hrs 30mins
<b>Dimensions</b>	Height 217mm 8.5 in.	Width 291mm 11.4 in.	Length 402mm 15.8 in.	Length inc handles 522mm 20.5 in.	Weight 26kg 57.2 lbs
<b>Logger</b>	Datapaq 9000 (DP9064)		Tpaq21		
<b>Heatsink</b>	1 × TB1069A		1 × TB1066A		

## TB4926

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	24hrs	12hrs	8hrs 30mins	6hrs	4hrs 30mins
<b>Dimensions</b>	Height 254mm 10 in.	Width 358mm 14.1 lbs	Length 443mm 17.4 in.	Length inc handles 563mm 22.2 in.	Weight 26kg 57.2 lbs
<b>Logger</b>	Tpaq21		Datapaq 9000 (DP9064)		
<b>Heatsink</b>	1 × TB1066A		1 × TB1069A		

## TB4933

<b>Temp. °C</b>	200	400	600	800	1000
<b>Temp. °F</b>	392	752	1112	1472	1832
<b>Duration</b>	27hrs	18hrs	10hrs 30mins	8hrs 30mins	7hrs 30mins
<b>Dimensions</b>	Height 304mm 11.9 in.	Width 406mm 16 in.	Length 613mm 24.1 in.	Length inc handles 733mm 28.8 in.	Weight 50kg 110 lbs
<b>Logger</b>	Datapaq 9000 (DP9064)		Tpaq21		
<b>Heatsink</b>	1 × TB1069A		1 × TB1066A		

## Changing Your Process

Be aware that using your thermal barrier for conditions other than originally specified (i.e. longer durations and/or higher temperatures) may cause serious damage to all parts of your Datapaq system. We strongly advise you to contact Datapaq Ltd to confirm your system is suitable for your new process. When contacting Datapaq Ltd, you will require the following information to give sufficient details of your new process profile:

1. Heating phase (time to reach soak temperature)
2. Soak time and temperature
3. Cooling phase (time from soak temperature to end of process)
4. Furnace atmosphere
5. Time from end of cooling phase to removal of the thermal barrier and the system being dismantled

*A lower process temperature can still result in serious damage to your system if the duration has been increased.*

# Care and Maintenance

## Thermal Barriers and Heatsinks

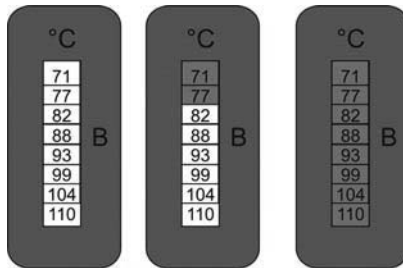
### Cooling

Stand hot thermal barrier on a Datapaq Barrier Stand. Alternatively use spacers, a ceramic fiber blanket or refractory material to ensure uniform cooling. Placing a hot thermal barrier directly onto a cold surface will probably cause the barrier to distort due to the different cooling rates of the surfaces. Datapaq will not be liable for damage caused by distortion due to incorrect handling of a barrier while cooling.

The heat absorbed by the thermal barrier will continue to affect the temperature of the heatsink and logger: **remove them from the thermal barrier as soon as the test is completed**, and leave them in the open to cool before further use; in most cases, cooling overnight is sufficient.

### Examination

Once cool, examine the thermal barrier and heatsink for damage. Examine the heatsink's thermometer strip. Refer to the diagram below:



### Ideal scenario

The first illustration is the ideal scenario. In this instance the heatsink has not reached 71°C/160°F. On cooling, the phase-change material will crystallizes back. Your system and process are compatible.

## **Possible problem**

The middle illustration indicates the temperature has exceeded 77°C /171°F. In this instance allow the heatsink to cool to room temperature, around 15°C (60°F) before placing in a freezer at -20°C /-5°F to cool overnight. You must do this to ensure the phase-change material crystallizes, as it may not do this at room temperature. Be aware however that your process is near the limit of the barrier's capacity.

After freezing allow the heatsink to return to room temperature, replace the thermometer strip before further use. To do this, peel off the heatsink's thermometer strip if it has recorded a temperature greater than 77°C/170°F and replace it. A self-adhesive replacement is supplied with the Tracker system; peel off the backing and attach it to the heatsink.

## **Confirmed problem**

The third illustration shows an extreme example where the heatsink has been exposed to a process beyond the systems thermal capacity. You will need to follow the procedure as described in the "possible problem" scenario, and also contact Datapaq for advice.

Contact Datapaq if the heatsink phase-change material leaks. It is a non-toxic wax-like substance that dries hard powdery white and has a slight acidic smell. Wait until it is dry before scraping of any material that has leaked onto the surface of the barrier.

Examine the cooled thermal barrier and heatsinks for damage before storing in a dry environment to avoid the insulation absorbing water.

Check the thermal barrier's seals and closing mechanism, and rectify any damage before further use.

## ***Adjusting Sealing Catches***

Sealing catches may require some adjustment; they can be easily set by hand using the following procedure.

### Series TB4000 Standard Range



Use a screwdriver to turn the adjusting screws under each thumb catch. Adjust such that slack is removed from the sealing catch when closed, and that slight pressure is required on the last part of the mechanism's travel. Thumb pressure is all that is required to close the catch.

### Series 4900 Severe Environment Range



Manually rotate the adjusting thumb screws between each thumb catch. Adjust such that slack is removed from the sealing catch when closed, and that slight pressure is required on the last part of the mechanism's travel. Thumb pressure is all that is required to close the catch.

Spare parts for catches are available from Datapaq.

#### **WARNING**

*Damaged catches should be replaced by Datapaq to ensure optimum barrier performance.*

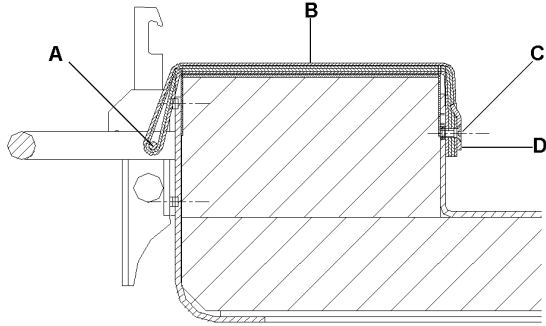
# Replacing the Thermocouple Wear-Strip

## Series 4900 severe environment range

The Mullite fiber wear-strips in the base and lid of the 4900 Severe Environment thermal barriers can be replaced by the user as follows.

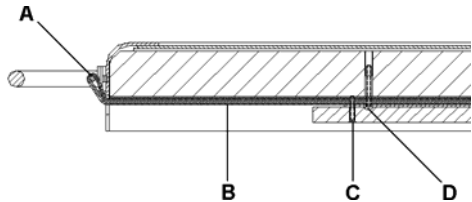
### Barrier Base

1. Undo the screws retaining the bracket that secures the wear-strip inside the barrier (C and D).
2. Remove the old Mullite fiber wear-strip (B).
3. Thread the new Mullite fiber wear-strip over the small diameter bar inset from the carrying handle (A), and over the face of the inside insulation.
4. Fasten the ends of the new wear-strip with the bracket and screws (C and D).



### Barrier Lid

1. Unscrew the six retaining screws (C and D), and remove the insulation layer and metal plate.
2. Remove the old Mullite fiber wear-strip (B).
3. Thread the new Mullite fiber wear-strip over the small diameter bar inset from the carrying handle (A).
4. Fasten the ends of the new wear-strip by replacing the insulation and metal plate. Replace the six screws (C and D).



## Series 4000 range

The Mullite fiber on the lid and base where the thermocouples exit will wear in use. It is however reinforced by a second layer of Mullite fiber cloth which gives added protection. When this second layer is visible it indicates that the top layer has worn to a point where it should be replaced by Datapaq.

# Thermocouple Probes



*Datapaq's comprehensive range of thermocouple probes.*

Thermocouple probes utilize the Seebeck effect, discovered in the nineteenth century, by which an e.m.f. is produced in any electrically conducting material that is not at uniform temperature. The actual voltage measured is proportional to the temperature difference between the thermocouple's 'hot' and 'cold' junctions (the hot junction being the measurement junction, and the cold junction being the junction of thermocouple and measurement instrumentation).

The practical implementation of thermocouples requires sophisticated electronics to eliminate potential measurement errors which include poor linearity over the measurement range, and inaccuracy due to temperature variations at the cold junction. To accommodate these the electronics in the measuring system must simulate a temperature of 0°C/32°F at the cold junction, as well as compensating for any non-linearity over the range of thermocouple operation.

Over the years, 'standard' thermocouples have been developed using materials chosen for sensitivity, linearity (consistency of sensitivity over the useful temperature range), price and availability. Current standards include types K, N, R, S and B, each type being identified by its connector color.

# Thermocouples Supported by Datapaq Systems

Probe Type	Typical Application	Previous Plug/Socket Color	IEC Plug/Socket Color
B	Kiln	White	Grey
K	General purpose	Yellow	Green
R/S	Kiln	Green	Orange
N	Furnace, kiln	Orange	Pink

## Thermocouple Specifications

Probe Type	Specified Temperature Range	Cable Insulation	Accuracy of Probes	Notes
B	Contact Datapaq			
K	0°C to +1,370°C/32°F to 698°F	PTFE, ceramic, mineral insulation, glass fiber	0–1,250°C ±1.1°C /32°F to 2280°F±2°F or ±0.4%, whichever is greater(ANSI MC96.1)	Datapaq supply Microbell™ sheath for high temperature operation
R/S	0°C to +1,760°C/32°F to 3,200°F	Ceramic tube	0–1,000°C ±1.1°C; 1,100–1,600°C±1°C + 0.003 (t-100)°C, where t=measurement temperature	Datapaq does not supply
N	0°C to +1,300°C/32°F to 2,372°F	Mineral insulation only	0–1,300°C ±1.1°C /32°F to 2372°F±2°F or ±0.4%, whichever is greater(ANSI MC96.1)	

## Thermocouple Insulation

The practical operating temperature of the thermocouple probes is limited by the cable insulation material's temperature characteristics.

Insulation	Upper Temperature Limit
PTFE	260°C /500°F
Glass fiber	0 to 600°C /1112°F continuous 700°C /1,292°F peak
Ceramic fiber	1,000°C /1,832°F
Mineral insulation (MI)	1,250°C /2,282°F if using Microbell™ or high temperature sheath

**PTFE** (polytetrafluoroethylene)-insulated probes are suitable for general-purpose use at temperatures up to 260°C (500°F). PTFE is a robust, flexible, non-stick material, normally used in Autoclave processes.

**Glass-fiber**-insulated probes.

Light gauge glass fiber insulated probes are flexible and are suitable for continuous operation at temperatures up to 600°C/1112°F, and short-term operation at temperatures up to 700°C/1,292°F. These thermocouples are generally used to monitor glass windscreen temperatures during bending operations.

**Ceramic-fiber**-insulated probes have light gauge conductors to provide maximum flexibility. The calibration of their exposed hot junction may be affected when in carbon atmospheres at temperatures in excess of 900°C/1,652°F. They are often used to monitor joint sealing and annealing profiles in the TV tube manufacturing industry.

**Mineral**-insulated (MI) probes have an enclosed junction providing protection against carbon and other aggressive atmospheres, and increased immunity to electrical interference. The MI probes supplied by Datapaq have a Microbell™ sheath which provides superior protection at high temperature and in corrosive atmospheres, but has some limitations in atmospheres with high sulfur content. Consult Datapaq for advice.

## Thermocouple Probes for Furnace Operation

Type K thermocouple probes have a hot junction combining nickel chromium alloy and nickel aluminum alloy. They are the standard probe for furnace operation.

International specifications for type K define a sensitivity and linearity over the range 0–1,370°C/32–2,498°F. The practical operating range is limited by the properties of the cable insulation (normally PTFE, mineral or ceramic fiber) or metallic sheathing.

# Mineral Insulated Type K Probes



*Type K Microbell™ sheathed mineral-insulated thermocouple probe suitable for furnace operation.*

General-purpose high-temperature probes covering the range 0–1,250°C /32–2,282°F. The cable has a Microbell™ metal outer sheath and internal mineral insulation. Applications include:

- General furnace applications
- Carburizing atmospheres
- Quenching (water and gas)
- Environments where electrical interference is present.

# Ceramic Fiber or Nextel™ Insulated Type K Probes



*Type K ceramic-fiber-insulated thermocouple probes suitable for furnace operation.*

High-temperature probes operating over the range 0–1,000°C/32–1,832°F. Designed for maximum flexibility, the conductors have a small diameter, typically 0.5 mm (24 AWG). Applications include:

- Glass industry
- Some furnace applications, including steel tempering

## **WARNING**

*Ceramic-fiber-insulated probes are **not** suitable for use in: carburizing atmospheres or environments with potential electrical interference (e.g. vacuum furnaces).*

# Care and Maintenance

The life expectancy of the thermocouples depends on the severity of the testing environment. However good care procedures will maximize their life.

## **Examination**

Examine the thermocouples sheath. Replace those that show evidence of cracking or wear.

## **Storing**

When coiling cables for storage, ensure the diameter of the coil is not less than:

- 20 cm/8 in. for 1.5-mm/ $1/16$ -in. diameter sheaths
- 40 cm/16 in. for 3-mm/ $1/8$ -in. diameter sheaths

## **Testing**

Please refer to Testing Thermocouple Probes on page 29.

## **Thermocouple Plugs**

If your system has thermocouple plugs fixed together as part of an internal wiring harness, it may be necessary to use a **small** amount of electrical lubricant on the plugs if they become difficult to remove.

# Datapaq Service Department

If you cannot resolve your problems, please contact the Service Department at Datapaq (see Title page for contact details).

# Running a Temperature Profile

This chapter describes all the stages of setting up for a profile run – including preparing the thermal barrier, positioning the probes and installing the complete system in the furnace.

To prepare the data logger, please refer to the dedicated logger manual, and the Insight software on line help.

## SAFETY

*Discuss the application of the Tracker system with your Health and Safety officer.*

*Wear appropriate protective clothing.*

*The Tracker components will be hot after the test run, so handle with care.*

*If appropriate, use lifting equipment when loading and recovering the system.*

## Setting Up

The insulation in your thermal barrier may have absorbed moisture during the manufacturing process. Thus, before using the barrier for the first time, run it (sealed and containing heatsinks if supplied, but excluding the data logger) once through your process to remove the moisture.

*Please note that although the barrier will be hot, it is very important that the barrier is dismantled immediately after exiting the furnace (please refer to the Care and Maintenance section). Failure to do this **will** result in serious damage to the heatsink.*

The insulation material may initially migrate when operating in a vacuum furnace. To avoid this material contaminating your product, surround the Tracker system with reject product for the first few runs.

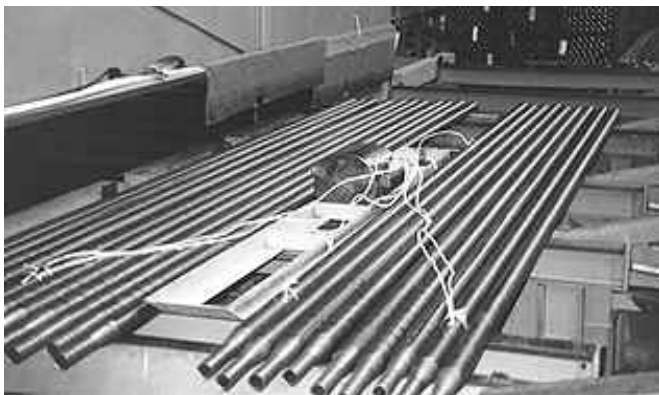
Setting the system up for a test requires a definition of the furnace's normal operating characteristics. These include:

- Line speed.
- Number of furnace zones.
- Maximum temperatures in each zone.
- Number, location and method of attachment of the thermocouple probes.

- The temperature profile which the thermal barrier is expected to experience.
- Furnace height and width restrictions.
- The change in thermal mass the presence of the thermal barrier will introduce into the furnace.
- The furnace atmosphere.

Please consult Datapaq for advice on setting up your system.

## Probe Selection, Location, Attachment and Testing



*A Furnace Tracker system ready to monitor tubes during an annealing process.*

### Probe Selection

Selection of thermocouple type and insulation is based on temperature range, measurement accuracy and process environment.

Thermocouples generally suitable for furnace application are type K.

Probe Type	Temperature Range	Cable Insulation	Accuracy of Probes Supplied by Datapaq
K	-150°C to +1,370°C/2498°F	Ceramic, mineral insulation, glass fiber	To ANSI MC96.1 specification: 0-1,250°C/2282°F ±1.1°C (2°F) or ±0.4%, whichever is greater

The cable insulation material limits the actual operating temperature. Maximum temperatures are:

Glass fiber	500°C /932°F
Ceramic fiber	1,000°C /1,832°F
Mineral insulation (MI)	1,250°C /2,282°F

Glass-fiber-insulated probes have light-gauge conductors to provide maximum flexibility and are generally used on glass windscreens.

Ceramic-fiber-insulated thermocouples have light gauge conductors to provide maximum flexibility. Unfortunately this insulation is subject to rapid wear and as a result its application is generally limited to use in the glass industry. The thermocouple is not enclosed; as a result carbon could migrate into the metal and so affect its calibration. They are therefore not suitable for use in a carbon atmosphere at temperatures in excess of 900°C /1,652°F).

Mineral-insulated probes have an enclosed junction providing protection against carbon and other aggressive environments, and increased immunity to electrical interference. They are always used in quench processes (water or gas). The mineral-insulated probes supplied by Datapaq have a Microbell™ sheath which provides superior protection at high temperature and in corrosive atmospheres but has some limitations in high-sulfur-bearing atmospheres; consult Datapaq for advice.

## ***Probe Attachment***



*Thermocouple probes being attached to a radiator test piece.*

Thermocouple probes measuring air and/or product temperature will be attached to:

- The product.
- A reusable product sample (a test piece).
- A test fixture.
- A combination of any or all of the above.

Methods of attachment include ceramic cement, bolting, welding and securing with high-temperature wire.

*Ensure probes are disconnected from the data logger if they are to be welded to the test piece.*

When necessary, the test piece is drilled to enable the thermocouple junction to measure the product's internal temperature. In this case, the thermocouple junction is held in place with ceramic paste or secured with high-temperature wire.

*The tip of the thermocouple probe **must** be in good mechanical contact with the product when monitoring surface temperature.*



*Furnace barrier with probes attached to test piece.*

Whatever the method of attachment, thermocouple probes must be held in place along their length to ensure they stay in position and do not catch or snag on the sides of the furnace or baffles. To ensure repeatability and ease of use, test pieces and test fixtures with permanently mounted thermocouples should be used whenever possible.

## Testing Thermocouple Probes

Although thermocouples are generally robust, they can be damaged during handling. Use the Datapaq type K digital thermometer to confirm their operation after installation but before the product enters the furnace.

1. Attach thermocouple number 1 to the thermometer's type-K connector.
2. Switch on the meter which should read ambient temperature. If the thermocouple cable is broken, the meter will indicate an open circuit.
3. If a satisfactory ambient reading is recorded, apply heat to the thermocouple tip via fingers or other heat source (if a cigarette lighter is used, apply for 1–2 seconds only). The thermometer should register an increase: if the thermometer reading does not change, the thermocouple is short circuit and must be replaced; if the thermometer shows a decrease, the thermocouple connections are reversed.
4. Repeat stages 1–3 for remaining thermocouples, replacing any damaged ones.



*A digital thermometer in use.*

## Installing the Logger Into the Thermal Barrier

*For correct selection of a suitable barrier, see 'Selecting the thermal barrier' p9.*

*Allow for the time taken to recover the Tracker system after the test when calculating the thermal performance requirement for the thermal barrier.*

*Before proceeding, ensure the thermal barrier has cooled sufficiently since its last use.*

### Ensuring a Good Seal

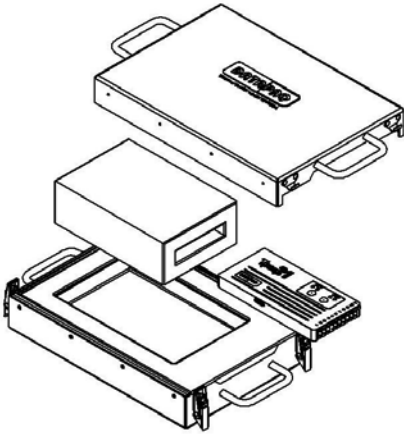
A good seal between thermal barrier and thermocouple cables must be maintained in order to ensure the data logger is protected. All Datapaq thermal barriers suitable for use in furnaces have adjustable lids to compensate for any shrinkage of the insulation material, and TB4900 series barriers also have provision for the section of Mullite fiber used to clamp the thermocouple cables to be replaced (see 'Adjusting sealing catches', page 16).

Thermal barriers with lid attachment via catches have adjustment to compensate for shrinkage.

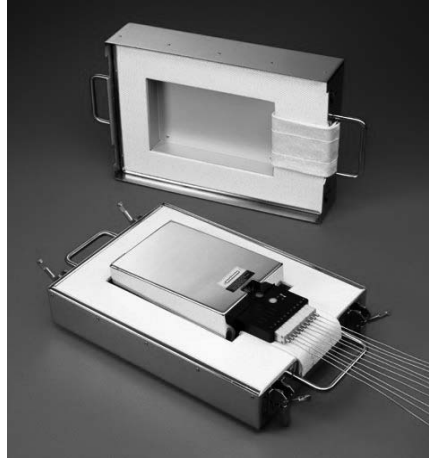
Materials used for any fasteners in the TB49000 series barriers (nuts and bolts) are normally 310 stainless steel, and are carefully selected to avoid seizing at high temperatures.

### ***Thermal Barriers with Heatsinks***

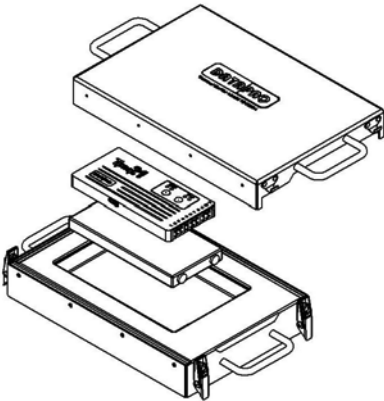
The following illustrations demonstrate how the logger and heatsink are installed. Note that for thermal barriers using a single slab heatsink, it is important that it is positioned under the logger.



Logger inserted into heatsink.



TB4912 with heatsink and Tpaq21.



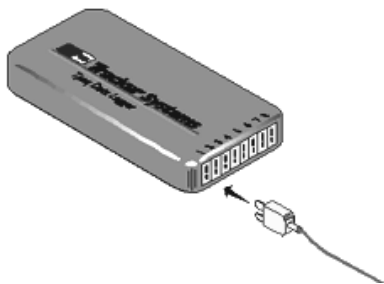
Heatsink underneath data logger.



TB4905 with heatsink and Tpaq21.

Using the illustrations as a guide, carry out the following procedure:

1. Plug the thermocouples into the data logger's numbered sockets. Note the socket number and the corresponding location of the thermocouple on the test piece.
2. Open the thermal barrier's lid, place the logger into the slot in the middle of the heatsink and slide the heatsink into the barrier. Lay the thermocouple cables across the Mullite fiber cloth to exit the barrier, ensuring they are side by side and do not cross other cables.



*Plugging a thermocouple into the logger.*

3. Close the lid ensuring a good seal around the thermocouple cables.

## The Furnace

### ***Furnace Type***

General furnace trials are carried out in mesh belt, roller hearth, pusher or rotary furnaces. Continuous furnaces such as mesh belt may be open at both ends or may contain doors at the entrance and exit which can be adjusted to let the thermal barrier through.

There may be 'dampers' or baffles within the furnace to separate the different zones and it is essential to establish the distance between the bottom of the damper and the belt as the thermal barrier could get caught. The product and system may sit directly on the mesh belt or rollers or may pass through the furnace in a product basket. In this instance, ensure the thermal barrier is within the bounds of the product basket.

### ***Atmosphere***

The atmosphere within a furnace may affect the performance of a thermal barrier. As an example, a vacuum will almost double the thermal duration of a barrier, whereas a hydrogen atmosphere will decrease performance by up to 30%.

Note however that a gas quench following a vacuum process will minimize any thermal advantage from the vacuum. This is because hot gas will penetrate the thermal barrier as pressure increases.

Furnace atmospheres will also have an effect on barrier corrosion. As an example, a TB4000 series thermal barrier in a normal combustion (air) will have a tendency to corrode at temperatures above 800°C/1472°F.

## Recovering the System

Consider carefully the recovery of the barrier from the furnace. Always be prepared before running a trial. Assemble any heat proof safety equipment (gloves, visors etc).

If it takes two persons to remove the system and test product, ensure it is clear who will do what!

- Who will pick up the barrier?
- Who will remove the test piece?

Make sure this is clear before you start the trial. Obvious? Yes, but frequently overlooked!

### WARNING

*Placing a hot thermal barrier directly onto a cold surface will cause the barrier's case to distort due to the different cooling rates of the surfaces. DataPaq can supply a custom stand for the barrier to be placed allowing optimum cooling and protection from distortion. Alternatively, stand hot thermal barriers on spacers, an insulating fiber blanket or refractory material to ensure uniform cooling.*

## Placing the System in the Furnace

When placing the thermal barrier into the furnace avoid placing it in a position where it will be exposed to large differences in temperature within the proximity of the barrier itself. For example avoid situations where a burner will fire directly at a face of the barrier, or where a gas quench will rapidly cool the barrier's upper face, but not the lower one. Subjecting the barrier to high thermal differential temperatures is likely to cause serious distortion of the barrier casing.

### SAFETY

*Discuss the application of the Tracker system with your Health and Safety officer.  
Wear appropriate protective clothing.*

*The Tracker components will be hot after the test run, so handle with care.  
If appropriate, use lifting equipment when loading and recovering the system.*

## ***Care of Thermocouple Probes***

Thermal cycling the probes may cause the MI cable to age, and eventually to become brittle. To avoid damaging cables and insulation, ensure the minimum bend radius is greater than 25 mm/1 in. If the sheath of an MI thermocouple shows evidence of cracking discard and replace it immediately.

## ***Thermal Barrier Presence in the Furnace***

The Furnace Tracker system has a thermal mass that absorbs heat during the heating cycles, and gives off heat during the cooling cycles. If this mass is significant compared to the thermal mass of the product it may affect the process. The presence of the system in the furnace may also affect the heating/cooling airflow. This must be taken into consideration when preparing for a test run.

## ***Checking the Clearance***

Check the minimum height and width through the process to ensure the clearance for the system and thermocouple probes is adequate.



# Recovering the System

## SAFETY

*Discuss the application of the Tracker system with your Health and Safety officer.*

*Wear appropriate protective clothing.*

*The Tracker components will be very hot after the test run, so handle with care.*

*If appropriate, use lifting equipment when loading and recovering the system.*

## Dismantling the System

### WARNING

*Placing a hot thermal barrier directly onto a cold surface will cause the barrier's case to distort due to the different cooling rates of the surfaces. Datapaq can supply a custom stand for the barrier to be placed allowing optimum cooling and protection from distortion. Alternatively, stand hot thermal barriers on spacers, an insulating fiber blanket or refractory material to ensure uniform cooling.*

Recover the system as soon as the test is over, remove **both** the heatsink and data logger from the thermal barrier as soon as it is positioned safely. Failure to remove the logger and heatsink from the hot barrier will cause serious damage to both.

If data acquisition has to be stopped manually, press and hold the logger's red stop button until the red and green status LEDs are on simultaneously. A flashing red LED indicates data stored in the logger but not yet downloaded to the PC.

Disconnect the probes from the logger and allow barrier and heatsink to cool to ambient temperature.

*An additional barrier or heatsink may be purchased if insufficient time is available to allow the barrier to cool between test runs.*

Once cool, examine the thermal barrier and heatsink for damage (see 'Care and Maintenance', page 15).

## Downloading Data

To prepare the data logger, please refer to the dedicated logger manual, and the Insight software on line help.



# Troubleshooting

## Checking Thermocouple Probes

Thermocouple probes are generally reliable, but damage resulting from inappropriate use or handling can produce erroneous readings. If you suspect that invalid data may have been introduced into your temperature profile (paqfile), select the View Data tab in the Insight software's Analysis Window to view the raw data as downloaded from the logger. The various types of invalid data which may be contained in a paqfile are shown in the analysis grid as follows.

- \*OC\* Open circuit.
- \*NA\* Data not available.
- \*LO\* Temperature measured was below the range of the logger.
- \*HI\* Temperature measured was above the range of the logger.
- \*\*\* Calculation cannot be performed (not necessarily because the data are invalid). Does not appear in View Data analysis mode.

Probes with an intermittent open circuit may produce spiky, erratic profiles. Note that spikes are inevitable when probes are disconnected from a live data logger while it is recording. Typical causes of invalid or interrupted data are:

- Thermocouple becoming detached from the logger.
- Faulty connection.

Faulty thermocouple readings which are inconsistent with those of other probes may be caused by a short circuit where un-insulated wires touch before the hot junction. This is known as a 'false hot junction' and can even occur within the thermal barrier if the insulation is damaged there.

In all cases the probe concerned must be replaced.



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