

# Oven Tracker<sup>®</sup> XL2

USER MANUAL

Issue 1

MA5150A





A Fluke Company

# Oven Tracker® XL2 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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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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Manual set in 10 pt Gill Sans.

User manuals are available in other languages;  
contact Datapaq for details.



The following product types

XL2 Thermocouple Data Logger  
manufactured by Datapaq Ltd.  
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comply with the requirements of European Union directives as follows.

Directive 2004/108/EC Electromagnetic Compatibility (EMC)  
*Standards Applied*

EN61326-1: 2006 – Group 1, Class B equipment (emissions section only), and Industrial Location Immunity (immunity section only).

CFR47: 2007 Class A – Code of Federal Regulations: Part 15 Subpart B, Radio Frequency Devices, Unintentional Radiators.

**RoHS Compliance** Datapaq temperature monitoring equipment is exempt from EU Directive 2002/95/EC (restriction of the use of certain hazardous substances in electrical and electronic equipment) under category 9 Monitoring and Control Instruments. This Datapaq product nevertheless uses RoHS-compliant components and manufacturing processes.



Conforms to relevant South Korean EMC Standards.

**Electromagnetic Compatibility** *Applies to use in Korea only.* Class A Equipment (Industrial Broadcasting & Communication Equipment). This product meets requirements for industrial (Class A) electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and is not to be used in homes.



# CONTENTS

## **9 Introduction**

- 11 System Components**

## **13 Insight Setup**

- 13 Installing/Removing Insight**
- 14 Communications Setup**

## **17 XL2 Logger Specifications and Operation**

- 19 Specifications**
- 20 Logger LEDs**
- 22 Dual Interface Block**
- 23 Memory Capacity**
- 23 Battery**
- 26 Over-temperature Protection**
- 26 Hardware Reset**
- 27 Testing and Calibration**
- 28 Disposal of Loggers**

## **29 Thermal Protection – Barriers and Heatsinks**

- 29 Aluminum Thermal Barriers**
- 31 Stainless-steel Thermal Barriers**
- 33 Selecting a Thermal Barrier**
- 34 System Carrying Cases**

## **35 Thermocouple Probes**

- 35 Thermocouple Specifications**
- 36 Thermocouple Cable Insulation**
- 37 Thermocouple Types and Accessories**
- 41 Working with Thermocouple Probes**

## **45 *Running a Temperature Profile***

**45 Overview**

**46 Resetting the Data Logger**

**50 Using SmartPaq**

**53 Installing the Logger in the Thermal Barrier, and Starting the Logger**

**55 Placing the System in the Oven**

**55 Removing the System from the Oven**

**57 Downloading Data**

**60 Preparing the Data for Analysis**

**61 Logger Defaults and Details**

## **63 *Using Hardwired Telemetry***

**63 Running a Temperature Profile Using Hardwired Telemetry**

## **67 *Troubleshooting***

**67 Logger Communications Problems**

**67 Logger Download Error Messages**

**67 Checking the Data**

**68 Logger Diagnostics**

**68 Datapaq Service Department**

## **69 INDEX**



# Introduction

Datapaq Oven Tracker® – incorporating Insight™ software, and designed specifically for use in the general coating and finishing industry – is a complete system for monitoring the temperature profiles of products within your oven; accurate data acquisition and powerful analysis techniques are combined with flexibility and ease of use. The Oven Tracker system's power and flexibility make it a perfect tool for process temperature monitoring, from commissioning and troubleshooting to process optimization, ensuring consistent quality of product and maximum efficiency.

Current temperature characteristics can quickly be compared with previously stored reference curves to detect operating abnormalities – and innovative analysis techniques help in identifying problems, fine-tuning the process and reducing running costs. A powerful and flexible printing option allows the user to generate and customize reports, including any or all of the analysis results or raw temperature data.

The basic Oven Tracker system hardware comprises:

- Data logger (including communications lead and charger).
- Thermal barrier.
- Thermocouple probes.

This manual contains information for all Oven Tracker users, from novice to experienced. The chapters are arranged in logical order, explaining the Oven Tracker system and the sequence of events in setting up and conducting a temperature profile run. There is also guidance on setting up the Insight software; complete information on using the software is contained in the online Help system available when it is installed.

**Insight Setup** (p. 13) – Initial setup of the Insight software, and its use in preparing the logger to obtain temperature-profile data and in downloading the data after the run. The use of hardwired telemetry is also described.

**XL2 Logger** (p. 17) – The data logger's specifications and basic operation.

**Barriers and Heatsinks** (p. 29) – Selection and use of the thermal-protection system.

**Thermocouple Probes** (p. 35) – Choosing from the wide range Datapaq probes available for different applications, and the methods for positioning and attaching them.

**Running a Temperature Profile** (p. 45) – Readyng the Tracker system for the oven, and recovering it after the temperature-profile run.

**Using Hardwired Telemetry** (p. 63) – Monitoring conditions inside a batch oven and watching a temperature profile develop in real time.

**Troubleshooting** (p. 67) – Lists software error messages and describes how to test the data logger and probes.

*For a rapid overview of the features of the XL2 logger and its step-by-step use with the Oven Tracker system, see the **Oven Tracker XL2 Quick Reference Guide**.*

*For full details on use of the Insight software, refer to the **online Help system** available when the software is installed.*



A typical standard Oven Tracker XL2 system.

For use of the StenterPaq and CoilPaq systems, and for use of the XL logger (including radio-telemetry), see the *Oven Tracker User Manual* (part no. MA5000A).

## System Components

A typical Oven Tracker XL2 system comprises:

- XL2 data logger (comprising MemoryPaq and Transducer Interface units), with communications lead and charger (p. 17).
- Optional Dual Interface Block with additional Transducer Interface.
- Thermal barrier (p. 29).
- Thermocouple probes (p. 35).
- Insight Oven Tracker software.
- *Oven Tracker XL2 User Manual*.
- *Oven Tracker XL2 Quick Reference Guide*.



# Insight Setup

Before the logger is used for the first time, you must:

1. **Install** Insight software.
2. Establish **communication** between the logger and the computer/software.

## Installing/Removing Insight

Datapaq Insight used with the XL2 logger requires the following minimum **computer specification**.

- 1 GHz processor.
- 2 Gb RAM.
- Monitor resolution 1024 × 768, 256 colors.
- 100 Mb free hard-disk space.
- DVD drive.
- 1 free USB port.
- Microsoft Windows™ XP, Vista, 7, 8 or above.
- Microsoft Internet Explorer 4 or above.

*The XL2 logger operates only with Datapaq Insight v.6.0 and above.*

## Installation

*Ensure you are logged into Windows in Administrator mode.*

For most systems, installation will start automatically on placing the Insight DVD in the drive. (If installation does not start, click the Windows Start button and select Run; browse to your DVD drive, and run Setup.exe.)

Follow the on-screen instructions. You will need your license number to hand, which is to be found on:

- Your license agreement.
- The outside of the DVD case.
- The outside of the system packaging.

Insight's link with the logger must also be made while Windows is in Administrator mode, and it is thus best to do this now, as part of the Insight installation: connect the logger to the PC and follow the procedure under

'Communications Setup' (below). Once this has been done, an operator will be able to use Insight with the logger connected to the PC without being in Administrator mode.

## **Upgrading**

It is not necessary to remove an existing version of the software before installing a new one. Settings and data files used with the current installation will be maintained.

## **Removal**

From the Windows Start button menu, select Settings and then Control Panel. Double-click Add/Remove Programs, select Datapaq Insight and click Add/Remove.

## **Using the Software**

Full details on using the Insight software are contained entirely within its online **Help system**: access this by clicking Help, and then Contents, on Insight's main menu. Then, within Help, click on Contents headings and topics to expand and read them.

You may also click the Help button in any dialog – or press the F1 key – to bring up help information relevant to the task being performed.

For use of Insight to **reset the logger**, see p. 46.

For **downloading data** from the logger, see p. 57.

# **Communications Setup**

After Insight has been installed, it is necessary to establish communication between the data logger and the PC. This will normally happen automatically when the logger is plugged into the PC: connect the logger to a free USB port and it will be ready to work. In case of any problems, note that the process should proceed as follows.

1. Using the communications lead supplied, connect the logger to a free USB port on the PC (to minimize communications problems, connect the lead first to the PC and then to the logger). The red LED on the logger should flash five times to confirm that the connection between the communications lead and the logger has been made.

If the PC is having a Datapaq logger connected for the first time, Windows will display a 'Found New Hardware' message and the PC is then ready to work with the logger. If any warnings are displayed about driver-signing, confirm them (Datapaq drivers have been tested, and were installed when Insight was installed).

## Typical sources of problems with establishing communication

- **Communications lead not fully inserted** – Check correct sockets are being used.
- **Damaged communications lead or connectors** – Check for breaks and other damage. Replace the lead.
- **Battery not charged** – Recharge the battery (p. 23), ensuring the charging LED is illuminated.

2. On the Insight software's menu bar, select **Logger > Setup** to open the **Communications Setup** dialog.
3. Click **Test**.

Please indicate whether your logger is connected to a serial port or a USB port.

Serial Port: CDM2

If you do not know which port your logger is connected to, click on 'Detect' and the software will try to find it for you.

USB Port  
[Your logger is connected to a USB port. Note that you don't have to specify which USB port is being used.]

Logger \_\_\_\_\_  
Click on 'Test' to see if the software can communicate with your logger.

MemoryPaq XL2 found on USB port

Logger	MemoryPaq XL2
Major Firmware Version	0
Minor Firmware Version	43
Maximum Temperature	85.0°C
Battery	45%
MemoryPaq ID	#13
Transducer Interface ID	#16
Range	-200.0°C to 1370.0°C

Probe	Readings	Probe	Readings
#1 (°C)	26.1	#5 (°C)	26.1
#2 (°C)	26.1	#6 (°C)	26.1
#3 (°C)	26.1	#7 (°C)	26.1
#4 (°C)	26.1	#8 (°C)	26.1
Internal (°C)	25.8		

The **Communications Setup** dialog for the XL2 logger, with **Diagnostic** section expanded.

If the logger is detected, its type and the port to which it is connected are displayed.

### **SHORTCUT**

*Pressing F4 on the keyboard opens the Communications Setup dialog, tests for communication with a logger, and displays the logger type and other data (equivalent to clicking Test in the dialog).*

For more information on the logger in use, click the Diagnostic button which now appears. Additional data shown covers firmware version, maximum permitted internal logger temperature, battery charge status, serial number and temperature recording range. If a Transducer Interface is attached, current temperature of the probes (updated once a second) is also shown – or open circuit (\*OC\*) if no probe is attached; the temperature of the thermocouple cold junction is effectively the current internal temperature of the logger.

## **Setting Frequency of Electricity Supply**

To increase the efficiency of the logger's noise rejection, and thereby provide more stable measurements, select the frequency of the local electricity supply as follows.

1. In the Insight software, select Tools > Options and click the 'Logger' tab and then the 'Advanced' button.
2. Select 50 or 60 Hz frequency. 50 Hz is most widely used, but 60 Hz is used in North America, several countries in South America, and in Japan and Korea.

# XL2 Logger Specifications and Operation

The basic XL2 data logger consists of two units:

- **Transducer Interface** – Digitizes data received from the thermocouple probes.
- **MemoryPaq** – Travels through the oven with the Transducer Interface, controls it, and stores the digitized data.

An optional **Dual Interface Block** allows two Transducer Interfaces to be connected to the MemoryPaq to increase the number of thermocouple probes used.



*The basic XL2 logger: an eight-channel Transducer Interface (left, showing thermocouple sockets) and MemoryPaq (right).*

The XL2 logger is at home in a wide range of thermal paint-cure applications. The 4 Mb onboard data-storage makes it a supremely powerful, accurate and in-depth data-collection tool; combined with its facility for hard-wired telemetry, which permits temperature profiles of batch processes to be seen developing in real time, this is an ideal logger for all applications.

The logger's key features are:

- Transducer Interface available with either **six or eight thermocouple channels**. For maximum data collection on each run, any two interfaces may be attached via a Dual Interface Block. The logger can thus easily be configured for a maximum of six, eight, 12, 14 or 16 thermocouple channels.
- **Intelligent multiple-run capability** – Store data from up to 10 temperature-profile runs, and download it later – simultaneously or selectively (p. 48, p. 57).
- **Memory** sufficient to store 10 runs, each with 16 probes, sample interval of 5 s, duration 60 minutes.
- **Minimum sample interval** 0.5 s.
- High **accuracy**:  $\pm 0.3^{\circ}\text{C}/0.5^{\circ}\text{F}$  for compliance to tight specifications (depending on conditions; see 'Specifications', below).
- Real-time data-collection by **hard-wired telemetry** for batch-process or development work.
- **Instant quality assurance** on removal from the oven. Use SmartPaq technology to pre-program the logger with your process's pass/fail criteria, and a green or red LED confirms the outcome immediately.
- **Hot-data protection and non-volatile memory** guarantee that you never lose data by mistake, even if the battery loses charge.
- **Robust** polycarbonate case and electronics specified to  $85^{\circ}\text{C}/185^{\circ}\text{F}$  provide system protection even during process delays. No fragile LCD to be at risk of damage in a production environment.
- Full **information on status** of logger's activity and its battery, at any time, from the robust clear LED lights and numeric display.
- **Start-stop simplicity**. To start, plug MemoryPaq into the Transducer Interface (or into the Dual Interface Block, if used); disconnect them to stop; reconnect to start next run. Alternatively, set data-recording to be triggered by rising temperature.
- **Factory default settings** for data-collection parameters are easily selectable by hardware switch.
- **Rechargeable NiMH battery**. 50-hour battery-life from 2-hour charge.
- Simplicity of **USB communication**.
- Cold-junction compensation guarantees **logger accuracy** despite heating inside the thermal barrier. Auto-shutdown of logger at  $85^{\circ}\text{C}/185^{\circ}\text{F}$  prevents compromise in data accuracy.
- For full certification and traceability, **calibration data** is stored in each Transducer Interface for instant access. **Logger and thermocouple correction factors** are easily applied by the Insight software (Oven Tracker Professional only) to maximize data confidence.

# Specifications

	<b>MemoryPaq + 1 × Transducer Interface 6 or 8 channels</b>	<b>MemoryPaq + Dual Interface Block + 2 × Transducer Interface 12, 14 or 16 channels</b>
<b>Length</b>	170 mm/6.7 in.	207 mm/8.1 in.
<b>Width</b>	75 mm/3.0 in.	75 mm/3.0 in.
<b>Height</b>	24 mm/0.9 in.	50 mm/2.0 in.
<b>Thermocouple Type</b>	K	
<b>Accuracy</b>	±0.3°C/0.5°F (logger at room temperature, measuring max. 200°C, max. 8 channels selected, sample interval 5 s or greater; for accuracy under other conditions, contact Datapaq)	
<b>Resolution</b>	0.1°C/0.2°F	
<b>Measurement range</b>	-200°C to 1,370°C/-328°F to 2,498°F	
<b>Operating temperature (without thermal barrier)</b>	0°C to 85°C/32°F to 185°F	
<b>Storage temperature (excluding battery)</b>	-55°C to 100°C/-67°F to 212°F	
<b>Humidity range</b>	0–85% non-condensing	
<b>Sample interval</b>	0.5 s to 1 s, in 0.1-s increments 1 s to 50 min., in 1-s increments	
<b>Memory capacity</b>	4 Mb (see p. 23).	
<b>Data-collection start</b>	Plug-and-go, or rising temperature	
<b>Pre-trigger data stored</b>	Yes (configurable; see p. 61)	
<b>Hot-data protection</b>	By non-volatile memory, and software warning if reset attempted before download	
<b>Logger reset</b>	Normally via Insight software. Hardware reboot and reset possible (p. 26), giving defaults of 5-s sample interval, plug-and-go trigger; data already collected is not deleted.	
<b>Onboard features</b>	Data analysis (SmartPaq function, see p. 50). Storage of calibration data and service history (see p. 27).	
<b>Multiple runs</b>	10 runs possible before download of data (see p. 48, p. 57)	
<b>Real-time monitoring</b>	Hardwired telemetry via communications lead	
<b>Over-temperature protection</b>	Warning or prevention of reset if internal temperature above user-defined level. Start of logging prevented above 45°C/113°F. Auto shutdown (data preserved) if internal temperature above 85°C/185°F. See p. 26.	
<b>Communications</b>	USB, using standard-A to mini-B cable.	
<b>Auto-detection by PC</b>	Yes (see p. 46)	
<b>PC/software compatibility</b>	See p. 13.	
<b>Battery</b>	Datapaq NiMH rechargeable battery-pack	
<b>Battery life</b>	57 hrs continuous use at room temperature with 5-s sample interval (see p. 25)	
<b>Battery charger</b>	CH0070B power-supply unit: input 90–264 V AC, 50–60 Hz, 400 mA	

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

## Logger LEDs

To conserve battery charge, the logger will power-off temporarily (e.g. LEDs will stop operating) if it has been inactive for 5 minutes (see p. 24).

On its front face, the logger is equipped with LEDs as follows.

### SmartPaq LED








If SmartPaq parameters have been setup for a pass/fail analysis on removal from the oven (see p. 50), the LED shows **green** for pass, **red** for fail.







### Logger Status LEDs

Red	Green	Meaning
Flashes 5 times (once per second), then stops	Off	Communications lead has established connection between logger and powered-up PC, or Logger has had hardware reset with default reset parameters (see p. 26)
Flashing, <i>together</i> with green LED, once per second	Flashing, <i>together</i> with red LED, once per second	Awaiting connection to Transducer Interface after being reset
Flashing, <i>alternating</i> with green LED, at sample interval *	Flashing, <i>alternating</i> with red LED, at sample interval *	Logger awaiting trigger (i.e. after Transducer Interface has been connected, if temperature trigger has been set)
Off	Flashing at sample interval *	Logger acquiring data
Flashing every 5 seconds	Off	Logger has data in memory which has not been downloaded
Double flash, together with green LED, every 5 seconds	Double flash, together with red LED, every 5 seconds	In multiple run mode, MemoryPaq is awaiting connection to the Transducer Interface to start the next run

\* Flashing interval will actually fall in range 0.5–5 s.

## Alphanumeric Display

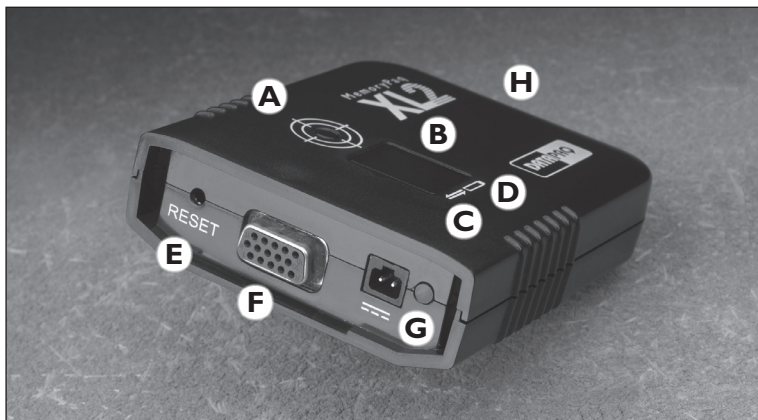
Display	Meaning
 Number (e.g. 0.5, 50)	Sample interval (in seconds). Sample intervals up to 9.9 s are shown to one decimal place.
	Sample interval too long to fit on display.
	One Transducer Interface connected (displayed briefly on connection).
	Two Transducer Interfaces connected (displayed briefly on connecting to Dual Interface Block).
 Flashing	Memory full, or contains data from 10 runs. Data must be downloaded before logging can resume.
 Flashing alternately	Logger communicating with PC.
 Snaking lights	SmartPaq calculation in progress.

Display	Meaning
	Internal error: reboot logger with default reset parameters (see p. 26). Contact Datapaq if problem persists.
	Error – Logger is hotter than 45°C (see p. 26).
	Error – At least one probe is hotter than trigger temperature; thus data-recording cannot be triggered by rising temperature.
	Error – All thermocouples are open circuit, or no thermocouples connected.
	Error – MemoryPaq and Transducer Interface not communicating properly when connected together. Connect them again.
	Error – Disconnect and re-connect communications lead.

## Battery LEDs

**Battery status** (front face of logger) – When flashing **yellow** once per second, battery is at 20% or less of maximum charge. Battery must be recharged.

**Battery charging** (next to charging socket) – **Red** when charging is in progress, **green** when charging is complete (see p. 23).



**LEDs and connectors on the XL2 MemoryPaq.**

- |                                   |   |
|-----------------------------------|---|
| A: SmartPaq LED.                  | F: Socket for Transducer Interface or Dual Interface Block. |
| B: Alphanumeric display.          | G: Charging socket and LED.                                 |
| C: Logger status LEDs.            | H: USB connector (on far end of unit).                      |
| D: Battery status LED.            |   |
| E: Hardware reset switch (p. 26). |   |

## Dual Interface Block

If a Dual Interface Block is fitted, either one or two Transducer Interfaces (each with any number of thermocouples connected) may be attached to it.



The XL2 logger: MemoryPaq (upper-right unit) with **Dual Interface Block** (central unit) and two Transducer Interfaces (left and lower right) attached.

To **start logging** when a Dual Interface Block is fitted, and plug-and-go is selected as the trigger mode (p. 49):

1. Ensure that **both Transducer Interfaces, with their probes connected**, are attached to the Dual Interface Block.
2. Plug the MemoryPaq into the Dual Interface Block.

*This sequence **must** be followed.*

Data-recording then starts, and the green logger-status LED starts flashing at the sample interval.

## Memory Capacity

The logger has 4 Mb of memory. In use, this total is divided between the number of probes attached; thus (for a given sample interval), the fewer probes selected, the longer the total run duration. Examples of run durations are shown below; if **multiple runs** (p. 48) are being performed, each duration given here is the total of all such runs:

Number of Probes	Number of Transducer Interfaces	Sample Interval	Total Run Duration
1	1	5 s	37.5 hrs
6	1	5 s	20.5 hrs
8	1	5 s	17 hrs
12	2	5 s	13 hrs
16	2	5 s	10.5 hrs

Memory is thus sufficient to store 10 runs of 60 minutes each, with 16 probes and sample interval of 5 s.

## Battery

The logger uses a pack of rechargeable nickel-metal-hydride (NiMH) cells. Expected battery life is about 500 charge–discharge cycles, or three years if sooner. The logger must be returned to Datapaq for **battery replacement**. Only battery packs supplied by Datapaq are suitable.

## Charging

Recharge the battery as follows.

1. Plug the charger into the electricity supply.
2. Connect the charger lead to the charging socket on the MemoryPaq.

Charging status is shown by the LED next to the charging socket: **red** when charging is in progress, **green** when charging is complete. A full charge is delivered within 2 hours. No light when the charger is attached indicates a problem: there may be a connection problem or the battery may need replacing.

New batteries – or ones which have been unused for several months – should be charged for 24 hours before use. NiMH batteries discharge slowly even when not in use and will need charging if left for more than three weeks.

Where batteries are too cold (below 0°C/-32°F), too hot (over 45°C/113°F) or too deeply discharged, the charging system will automatically **pre-condition** them before proper charging begins. Pre-conditioning (slow charging) takes extra time, but if the battery is still being pre-conditioned (i.e. the logger is showing a red charging LED) after 5 hours there may be a fault; contact Datapaq.

*The logger intelligently monitors the battery, ensuring it is never overcharged. Thus, by leaving the charger connected to the electricity supply, the logger will always be on charge and ready for use. This will not damage the battery or reduce its service life.*

## **Low Battery Level**

When the battery's charge drops to 20% of the full level, this will be shown by the flashing yellow battery status LED on the logger, and (if connected to the PC) by the Insight software. When the battery is empty, the logger shuts down, preserving data already gathered – and, when the data is downloaded, Insight will give a warning that this has happened.

## **Auto Power-off**

To conserve battery charge, the logger will power-off temporarily (e.g. LEDs will stop operating) in the following situations:

- When it has been inactive for 5 minutes, whether or not it is connected to the PC.
- Immediately it is disconnected from the PC if it does not contain data from a previous run which has not been downloaded (e.g. after a reset or download).
- When it has been indicating an error (alphanumeric display showing EI, etc. – p. 21) for 5 minutes.

*Any data contained in the logger's memory will not be lost.*

The logger will automatically come out of power-off mode when:

- The communications lead (which is connected to a powered PC) is plugged in, or
- A Transducer Interface is connected to the MemoryPaq, or
- A hardware reset is performed (see below).

On power-up, the logger will return to its pre-power-off state.

## **Battery Life**

Battery life (discharge time) of NiMH rechargeable batteries is affected by the following factors.

- **Operating Temperature** – Essentially, the higher the ambient temperature the battery operates in, the shorter will be the life. Batteries that operate for a large part of the process cycle at relatively low temperatures will have a longer life than those that operate for the majority of the process cycle at the maximum operating temperature.
- **Sample Interval** – The shorter the sample interval, the shorter will be the battery life. This is because power is being consumed each time the logger takes a reading. A short sample interval will achieve the maximum amount of information, but this must be balanced against the greater battery charge required.
- **Resetting the Logger, and Downloading Data** – When these operations are carried out it is necessary to connect the logger to the computer via the communications lead, and power is consumed whenever they are connected. The software warns the user to disconnect from the PC when the operation is complete in order to preserve battery life.

Given the factors that can affect the life of a battery it is obviously difficult to predict it accurately. The battery status LED on the logger (see above) will give the best indication of when the battery is low. In the user's own conditions, experience will quickly indicate typical battery life, and a log should be kept for the first few runs, noting the sample interval. The following data can serve as a guide – though values given here are no more than an indication of the battery life that can be expected.

<b>Sample Interval</b>	<b>No. of Channels</b>	<b>Logger Temp.</b>	<b>Battery Life</b>
0.5 s	8	25°C/77°F	25 hrs
5.0 s	8	25°C/77°F	50 hrs
20.0 s	8	25°C/77°F	60 hrs

# Over-temperature Protection

The XL2 and the Insight software work together to reduce the likelihood of corrupt or inaccurate data being recorded due to the logger's internal temperature being too high. The logger measures its internal temperature within the Transducer Interface; the internal temperature of the MemoryPaq is not monitored.

- Insight can be instructed to **show a warning message if a reset is attempted** (p. 46) when a currently connected Transducer Interface is above a specified temperature (default 45°C/113°F); see p. 61.
- Insight can be instructed to **prevent a reset** when a currently connected Transducer Interface is above a specified temperature (default 45°C/113°F); see p. 61.
- The logger **will not start logging** if the Transducer Interface is above 45°C/113°F.
  - Error E1 (p. 21) will then show when the Transducer Interface is connected to the MemoryPaq.
  - The logger will continue to check the internal temperature, and, if the temperature drops to 45°C/113°F during the next five minutes, logging will start; if the temperature stays above 45°C/113°F for 5 minutes, the logger will power-off.
  - Disconnecting and reconnecting the MemoryPaq and Transducer Interface will cause the internal temperature to be checked again for 5 minutes.
- If the logger's internal temperature exceeds 85°C/185°F, it shuts down, preserving data already collected. When the data is downloaded, Insight will give a warning that this has happened.

*The logger records its internal temperature during a profile run. For access to this data, see p. 61.*

## Hardware Reset

Resetting the logger is normally done using the Insight software (p. 46), but, in the event of a serious internal logger error, reset can be done without attaching the logger to a PC. The reset parameters will be restored to the factory defaults:

- Sample interval: 5 s.
- Trigger mode: plug-and-go.

*Thus, a hardware reset can also be used as a way of **quickly restoring the default data-collection parameters** without connecting the logger to a PC.*

*Unlike a normal reset, a hardware reset will **preserve in memory all data already collected** – it will not be deleted.*

To perform a hardware reset:

1. Remove the Transducer Interface or Dual Interface Block, if attached.
2. Locate the small hole housing the reset button in the mating surface of the MemoryPaq (p. 22), and press in briefly with a pointed object (e.g. a pen).
3. The red logger-status LED (p. 20) will flash five times to confirm reset.

## Testing and Calibration

It is recommended that the logger is tested and calibrated by Datapaq at least once a year. The Datapaq calibration procedure comprises:

- Inspection of the logger, externally and internally.
- Battery- and charge-testing.
- Heat-cycle test of up to 14 hrs in Datapaq's own ovens.
- Stability testing, using a stable temperature source and varying ambient temperatures.
- Calibration and updating of the logger's firmware.
- Issue of certificate, which can be traced back to national calibration standards.

No other company can offer this degree of in-depth testing as well as a full calibration service. To calibrate your logger, please return it to the Service Department at Datapaq (see title page for contact details).

For full certification and traceability, calibration data is stored in each Transducer Interface for instant access by Datapaq engineers. To **print a calibration certificate** for a Transducer Interface, select File > Print Calibration Certificate and make the appropriate selection in the dialog in order to print a certificate either for:

- The Transducer Interface which was used to create the currently displayed paqfile (temperature profile). *or*
- The Transducer Interface which is currently connected to the PC (via the MemoryPaq).

For processes of **testing your logger's operation** with thermocouples attached, see p. 43.

**Store the logger** in a dry, dust-free environment.

# Disposal of Loggers

Always adhere to the applicable statutory regulations for recycling and waste disposal. For details of recycling Datapaq products within the European Union, see [www.fluke.co.uk](http://www.fluke.co.uk).



Under the European Union WEEE Directive, users should return all loggers (whether or not containing batteries) to Datapaq for disposal at the end of their useful life.



# Thermal Protection – Barriers and Heatsinks

A Datapaq thermal barrier provides the thermal and mechanical protection necessary for the data logger to survive in the hostile environment of an industrial oven.

Ceramic insulation covered by a ceramic fiber cloth provides the primary thermal protection, and a heatsink filled with a non-toxic, non-flammable phase-changing material provides additional, secondary protection allowing the system to operate at high temperatures for extended periods. The phase-changing material absorbs the heat and maintains a temperature of 58°C/136.4°F until all the material has changed from solid to liquid state.

*The ceramic insulation material will absorb **moisture** if stored in a damp environment – and this may also happen during the thermal barrier’s manufacture.*

*Although this will not damage the barrier, its performance will be degraded until the moisture is removed. Thus, if you suspect this has happened, or if using a **new barrier**, run it (sealed and containing heatsinks if supplied, but excluding the data logger) once through your process to remove the moisture.*

*To eliminate risk of contamination, **it is strongly recommended that barriers are examined after each use** (see p. 56): check the seals and integrity of the insulation carefully. If damaged excessively, it is possible that insulation material may escape and cause particulate contamination within the oven. If in any doubt about the safety of the equipment, or contamination, contact Datapaq.*

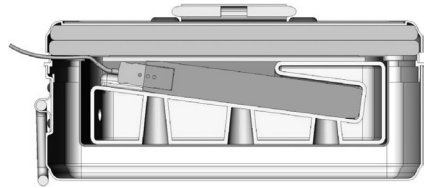
## Aluminum Thermal Barriers

These barriers’ key features are:

- Casing made from deep-drawn **aluminum** for lightness.
- Steel probe-plate on lid for convenient attachment of magnetic probes.
- **Handles at side and top** for convenience of carrying and for hanging in the oven. Handles can be **locked** into position for extra ease and safety when recovering from hot oven.
- **Indented lid** allows easy grasp of handle with gloved hand.
- **Strong catches** with locking pins to maintain secure lid even if dropped.
- Patented use of specialized **silicone-free materials** for insulation and sealing in the barrier avoids contamination issues. All materials used in the

TB0090 and TB0091 barriers have been independently tested by an automotive paint laboratory, and proven to be non-crater-forming in both solvent and water-based paint processes.

- **Angled heatsink** (TB0090) holds logger securely in open barrier, even if vertical, and allows strain-free routing of cables out of the barrier.
- Safe operation for **3 hrs at 200°C/392°F** (TB0090) gives assurance during multiple runs and process delays.



XL2 aluminum thermal barriers and their heatsinks: TB0090 (left) and TB0091 (right).

### TB0090 Standard XL2 (with Heatsink)

Typical applications: automotive assembly and components, general paint/powder/E-coat processes.

<b>Temp °C</b>	100	150	200	250	300
<b>Temp °F</b>	212	302	392	482	572
<b>Duration (hours)</b>	11	5.0	3.0	1.8	1.0
<b>Dimensions</b>	Height 134 mm 5.3 in.	Width 187 mm 7.4 in.	Length 296 mm 11.7 in.	Weight 3.65 kg 8.0 lb	
<b>Heatsink</b>	1 × TB9950A				

## TB0091 Low-height XL2

Typical applications: 2-piece can manufacture – internal-bake ovens, low-height mesh-belt ovens, portable system for travelling paint reps.

*With Heatsink*

<b>Temp °C</b>	100	150	200	250	300
<b>Temp °F</b>	212	302	392	482	572
<b>Duration (mins)</b>	270	150	105	75	48
<b>Dimensions</b>	Height 104 mm 4.1 in.	Width 187 mm 7.4 in.	Length 291 mm 11.5 in.	Weight 3.2 kg 7.1 lb	
<b>Heatsink</b>	1 × TB9115B				

*Without Heatsink*

<b>Temp °C</b>	100	150	200	250	300
<b>Temp °F</b>	212	302	392	482	572
<b>Duration (mins)</b>	106	66	49	42	35
<b>Dimensions</b>	Height 104 mm 4.1 in.	Width 187 mm 7.4 in.	Length 291 mm 11.5 in.	Weight 2.3 kg 5.1 lb	
<b>Insert Tray</b>	1 × TB9121				

## Stainless-steel Thermal Barriers

### TB0080 High-temperature XL2 (with Heatsink)

Typical application: high-temperature coating cure, e.g. PTFE, Dacromet.

<b>Temp °C</b>	200	300	400	500	600
<b>Temp °F</b>	392	572	752	932	1,112
<b>Duration (mins)</b>	300	180	120	100	75
<b>Dimensions</b>	Height 150 mm 5.9 in.	Width 215 mm 8.5 in.	Length 335 mm 13.2 in.	Weight 7.8 kg 17.2 lb	
<b>Heatsink</b>	1 × TB9115B + 1 × TB1001				

### TB0081 Long-duration XL2 (with Heatsink)

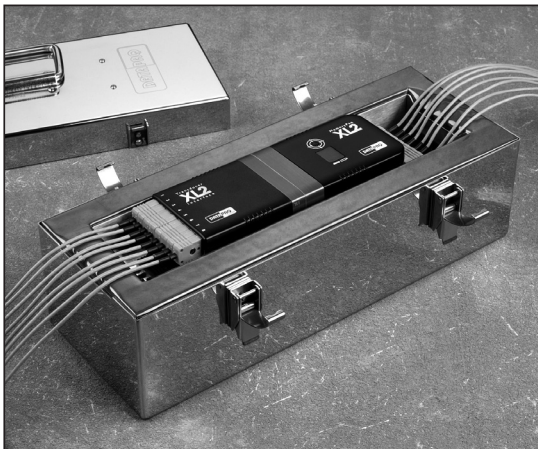
Typical applications: aluminum age-hardening, long low-temperature cure, automotive single-pass; possible to send the system through the complete paint process in an uninterrupted run – electrocoat (E-coat), primer, base and clear coat.

Temp °C	100	150	200	250	300
Temp °F	212	302	392	482	572
Duration (hours)	24	13	9	6	–
Dimensions	Height 182 mm 7.2 in.	Width 236 mm 9.3 in.	Length 370 mm 14.6 in.	Weight 10.5 kg 23.1 lb	
Heatsink	1 × TB9963 + 1 × TB1001				

### TB0083 For Dual Interface Block XL2 (with Heatsink)

This barrier is constructed of **silicone-free materials** (see p. 29).  
Typical application: automotive assembly.

Temp °C	100	150	200	250	300
Temp °F	212	302	392	482	572
Duration (hours)	11	5	3	1.8	–
Dimensions	Height 144 mm 5.7 in.	Width 172 mm 6.8 in.	Length 390 mm 15.4 in.	Weight 5.95 kg 13.1 lb	
Heatsink	1 × TB9960				



*TB0083, a stainless-steel thermal barrier for the XL2 in 1/6-channel configuration – shown with heatsink and logger in place.*

## TB5010-XL IP65 Waterproof XL2 (with Heatsink)

Typical applications: dry-off ovens, processes with water-shower rinse. This barrier is not silicone-free.

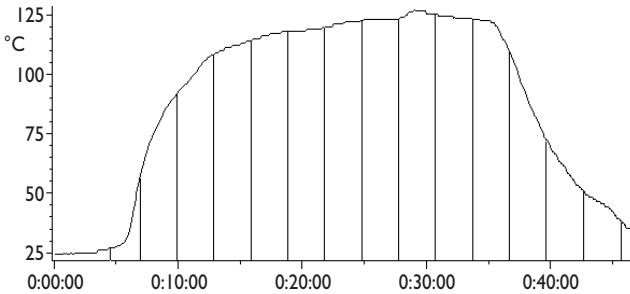
Temp °C	100	150	200	250	300
Temp °F	212	302	392	482	572
Duration (mins)	270	150	105	75	48
Dimensions	Height 100 mm 3.9 in.	Width 219 mm 8.6 in.	Length 393 mm 15.5 in.	Weight 6.0 kg 13.2 lb	
Heatsink	1 × TB9963				

*A wide range of thermal barriers is available from DataPaq for use with loggers other than the XL2.*

## Selecting a Thermal Barrier

The protection which the thermal barrier needs to provide for the logger depends on the nature of the process whose temperature is being profiled – primarily its temperature and duration. Selection of the appropriate barrier needs thus to be done carefully, as follows.

1. Plot a graph of the temperature versus time characteristics of the process.
2. Divide the horizontal axis into equal increments and draw verticals. Read the temperature at each vertical. (The number of verticals is determined by the complexity of the profile's shape: more are required when the shape is complex, fewer when it is simple.)



*A typical temperature profile experienced by an automotive component during curing. The average temperature is 90°C/194°F.*

3. Divide the sum of the temperatures by the number of verticals to calculate the average temperature. Modify this temperature as follows:
4. Add 15% if the maximum temperature is reached in the first third of the process.
5. Add 10% if the maximum temperature is reached in the first half of the process.
6. Taking into account the process height and width restrictions, select a barrier meeting or exceeding this temperature/time profile.

## System Carrying Cases

Datapaq cases provide convenient transportability for a complete Oven Tracker XL2 standard system, including a TB0090 or TB0091 thermal barrier. The lockable hard system case is ideal for air travel as checked-in baggage.



*Hard carrying case (CC0057, left and top right) and soft case (CC0055, bottom right).*

# 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 T, each type being identified by its connector color.

## Thermocouple Specifications

The standard thermocouple probe for oven operation is **type K**, which has a hot junction combining nickel-chromium alloy and nickel-aluminum alloy. International specifications for type K define a sensitivity and linearity over the range 0–1,250°C/32–2,282°F, though operating range is limited in practice by the cable insulation (see below).

Oven Tracker thermocouples supplied by Datapaq are exceptionally durable, quad-wrapped, 10-strand 36 AWG (0.125 mm/0.005 inch).

Probe Type	Temperature Range	Cable Insulation	Accuracy of Probes Supplied by Datapaq
K	-150°C to 1,370°C/ -238°F to 2,498°F	PTFE, ceramic, mineral insulation, glass fiber	±1.1°C/2.0°F (or ±0.4% if greater) at 0–1,250°C/32–2,282°F

*Type K thermocouples supplied by Datapaq formerly had yellow connectors and red cables but are now supplied with **green connectors and cables**, following the IEC584 color standard.*

# Thermocouple Cable Insulation

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

Insulation	Upper Temperature Limit
Glass fiber, thin	500°C/932°F
Glass fiber, thick	500°C/932°F continuous, 700°C/1,292°F peak
Mineral insulation (MI)	1,250°C/2,282°F
PTFE	265°C/509°F

**Glass-fiber**-insulated probes are available in both thin and thick forms. Impregnated with a silicone resin binder, thin-glass-fiber-insulated probes are more robust than thick-glass-fiber-insulated probes; they are suitable for use at temperatures up to 500°C/932°F. Thick-glass-fiber-insulated probes are more flexible than thin, being less impregnated with silicone resin; they are more suitable for oven use, and are capable of continuous operation at temperatures up to 500°C/932°F, and short-term operation at up to 700°C/1,292°F. They can be used when probe cables are close to heating elements.

**Mineral**-insulated (MI) probes have an enclosed junction providing increased immunity to electrical interference. Less flexible than PTFE or glass fiber, but suitable for use up to 1,250°C/2,282°F, they can be used when probe cables may be close to heating elements.

**PTFE** (polytetrafluoroethylene)-insulated probes are suitable for general-purpose use at temperatures up to 265°C/509°F. PTFE is a robust, flexible, non-stick material, with a low thermal mass and therefore a quick response time. This is the standard insulation for oven use, though **it cannot be used when probe cables may be close to infra-red heating elements.**

## WARNING

*PTFE does not support combustion, but decomposes above 265°C/509°F producing small amounts of toxic fumes.*

The important products from PTFE thermal decomposition are as follows.

At Temperatures Greater Than	Product
400°C/752°F	See note*
430°C/806°F	Tetrafluoroethylene
440°C/824°F	Hexafluoropropylene
475°C/887°F	Perfluoroisobutylene
500°C/932°F	Carbonyl fluoride*, which, in moist air, converts to the acid gas hydrogen fluoride

\* May also be produced if PTFE tape is kept at 400°C/752°F for an extended time.

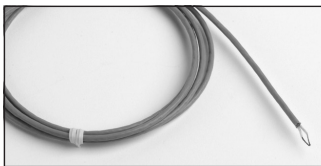
## Health-hazard Data

- Inhalation of decomposition products from PTFE can produce ‘polymer fume fever’, which has symptoms similar to influenza.
- There is no risk from ingestion or skin contact.
- There are no medical conditions generally aggravated by exposure to PTFE.

## Emergency and First-aid Procedures

- If there is accidental contact with PTFE fumes, remove the person concerned to clean air.
- Self-contained breathing apparatus and protective clothing should be worn when fire-fighting.

# Thermocouple Types and Accessories



### Exposed-junction Thermocouples

Taped, spot-welded or soldered direct to components for measuring surface temperature. Can also be used to measure air/environmental temperature.

*PTFE-insulated cable, maximum 265°C/509°F*

PA0063	1.5 m/5 ft
PA0065	2.0 m/6.5 ft
PA0064	3.0 m/10 ft
PA0071	8.0 m/26 ft

*Glass-fiber-insulated cable, maximum 500°C/932°F*

PA0182	1.5 m/5 ft
PA0181	2.0 m/6.5 ft
PA0180	3.0 m/10 ft



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## High-temperature adhesive tape

For securing exposed-junction thermocouples. Pressure-sensitive silicone adhesive. Maximum 400°C/752°F.

HT0090 9 m/29.5 ft

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## Silicone-free High-temperature Kapton Sheet

For securing exposed-junction and patch probes in automotive applications. Pressure-sensitive acrylic adhesive. Maximum 200°C/392°F. Cut to size and remove backing paper before use.

CS2090 200 × 300 mm/7.9 × 11.8 in.

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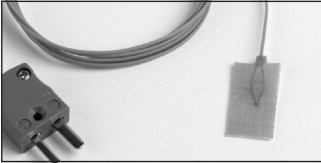


### MicroMag Thermocouple Mount

For securing exposed-junction thermocouple to ferrous substrate to measure temperature of air or (using high-temperature tape) substrate.

PA0980

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### Adhesive-patch Thermocouple

Attaches directly to light-gauge metal or plastic with adhesive patch and/or high-temperature tape. Ideal where fast response is required or in infra-red processes. PTFE-insulated cable. Maximum 265°C/509°F.

PA0060 1.5 m/5 ft

PA0062 3.0 m/10 ft

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### MicroMag Magnetic Thermocouples

Attaches directly to ferrous substrate using strong SmCo magnet with diameter only 17 mm/0.67 in. Ideal for measuring temperature in tightest of recesses (aluminum knob can be removed). PTFE-insulated cable. Maximum 265°C/509°F.

*Air Thermocouple*

PA0995 1.5 m/5 ft

PA0996 3.0 m/10 ft

PA0999 6.0 m/20 ft

*Surface Thermocouple*

PA0973 1.5 m/5 ft

PA0974 3.0 m/10 ft

PA0975 6.0 m/20 ft

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### Surface Offset Magnetic Thermocouple

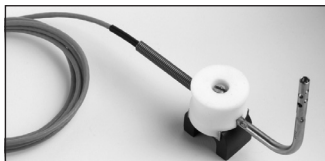
Attaches directly to flat ferrous substrate to measure surface temperature. PTFE-insulated cable. Maximum 265°C/509°F.

PA0053 1.5 m/5 ft

PA0054 3.0 m/10 ft

PA0050 6.0 m/20 ft

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### Air Magnetic Thermocouple

Attaches directly to ferrous substrate to measure air/ environmental temperature. PTFE-insulated cable. Maximum 265°C/509°F.

PA0055	1.5 m/5 ft
PA0056	3.0 m/10 ft
PA0059	6.0 m/20 ft



### Washer Thermocouple

Screwed directly to large heavy metal substrate. PTFE-insulated cable. Maximum 265°C/509°F.

PA0081	1.5 m/5 ft
PA0082	3.0 m/10 ft



### Clamp Surface Thermocouple

Clips to non-ferrous component to measure surface temperature.

*PTFE-insulated cable, maximum 265°C/509°F*

PA0011	1.5 m/5 ft
PA0012	3.0 m/10 ft
PA0016	6.0 m/20 ft

*Glass-fiber-insulated cable with stainless-steel outer braid, maximum 400°C/752°F*

PA1710	1.5 m/5 ft
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### Clamp Air Thermocouple

Clips to non-ferrous component to measure air/ environmental temperature.

*PTFE-insulated cable, maximum 265°C/509°F*

PA0021	1.5 m/5 ft
PA0022	3.0 m/10 ft
PA0025	6.0 m/20 ft

*Glass-fiber-insulated cable with stainless-steel outer braid, maximum 400°C/752°F*

PA1720	1.5 m/5 ft
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### AluClamp Surface Thermocouple

Clips to edge of aluminum car hood/bonnet, or any non-ferrous panel, to measure surface temperature. Arm reaches 300 mm/12 in. PTFE-insulated cable. Maximum 265°C/509°F.

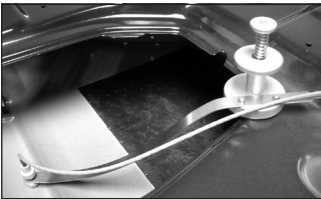
PA1351A	1.5 m/5 ft
PA1352A	3.0 m/10 ft



### IRMag Surface Thermocouple

Magnetic attachment (maximum 300°C/572°F), to measure surface temperature of ferrous substrate in infra-red cure oven. Easy attachment and fast thermocouple response. High-temperature glass-fiber-insulated cable with stainless-steel outer braid prevents damage from infra-red heaters (maximum 400°C/752°F). Ideal for automotive infra-red repair ovens.

- PA1361A 1.5 m/5 ft
- PA1362A 3.0 m/10 ft
- PA0980 Replacement mount
- PA1371 1.5 m/5 ft Replacement cable and guide
- PA1372 3.0 m/10 ft Replacement cable and guide



### Aluminum Automotive Body Shell Surface Thermocouple

Surface-temperature measurement in aluminum car body shell. Spring-loaded bobbin clips to any recess in inner car body skin. Sprung-steel arm is adjusted to position sensor on outer body skin. PTFE-insulated cable. Maximum 265°C/509°F.

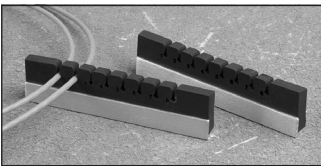
- PA0030 Spring-action mount
- PA0032 1.5 m/5 ft cable, with arm assembly
- PA0033 3.0 m/10 ft cable, with arm assembly



### Aluminum Automotive Body Shell Air Thermocouple

Air-temperature measurement in aluminum car body shell. Spring-loaded bobbin clips to any recess in inner car body skin. PTFE-insulated cable. Maximum 265°C/509°F.

- PA0030 Spring-action mount
- PA0036 1.5 m/5 ft cable, with arm assembly
- PA0037 3.0 m/10 ft cable, with arm assembly



### Thermocouple Cable Tidy

Keeps cable routing even, prevents kinking and tangling, and helps with probe identification and handling. Up to eight cables.

- PA2050A



### Thermocouple ID Tags

Aluminum tags fitted to sensor end of thermocouple cable to allow clear identification of probe number even when thermal barrier is closed.

- PA2051A Set numbered 1-8



### **Hanging Strap**

Mild-steel strap to be hung from thermal barrier. Clamp or magnetic thermocouples can be attached to it for easy transport of the system – or use to attach thermocouples between runs.

PA2052

## **Working with Thermocouple Probes**

Datapaq probes cover a huge range of possible usages. Choose suitable types for your process, and for the individual probes' locations, from the those listed above.

The process temperature may determine the choice of thermocouples' insulation material. PTFE is to be preferred if the temperature of the process is low enough to permit its use; see p. 36.

### **Probe Location**

The product's geometry and the process's thermal requirements define the number and location of the thermocouples required for the test. In some instances it is necessary to install an array of thermocouples to provide coverage over the entire area of the product. In others, the thermocouples are located to monitor a specific part of the product.

An array of air probes can provide a view of temperature distribution across the oven, enabling adjustment of heaters and/or baffles. Measurements on the surface of the product characterize heat absorption from the air and thus determine the actual temperature/time profile to which it is subjected. A combination of air and surface probes enables the rate of heat absorption to be determined, and thus permits adjustments to optimize thermal efficiency and product quality.

If required, data acquisition can be triggered by temperature, in which case the trigger is normally taken from an air probe. On the XL2 logger, this may be connected to any thermocouple channel.

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

- The product.
- A reusable product sample (a test-piece).
- A test-fixture (a structure simulating the product, with probes positioned appropriately).

In assessing oven performance, to ensure repeatability and ease of use, test-pieces or test-fixtures with permanently mounted thermocouples should be used whenever possible.

The presence of a probe on the product will inevitably affect the product's temperature: it adds to its thermal mass and thus changes, however slightly, the rate of heating and cooling. Probes of large thermal mass are unsuitable for use with small, lightweight products.

Placing a probe between the source of heat and the product can affect the rate of heating. To minimize the effect, attach the probe to the product's unheated side where possible, and/or reduce the probe's thermal mass.

Glass-fiber or mineral insulation must be used if thermocouple cables are close to infra-red heating elements or are subject to temperatures over 260°C/500°F.

Route cables to ensure that they are:

- Secured in position along their length.
- Not fouling elements in the oven.
- Not thermally shading the product.
- Not too close to heater elements.

## **Probe Attachment**

*The tip of the thermocouple probe must be in **good mechanical contact** with the product when monitoring surface temperature. Poor thermal contact will at best result in slowing the rate at which the product heats the probe and at worst prevent the probe from achieving the same temperature. Ensure probe tips are clean before attaching.*

The following methods may be used.

### **Surface Measurement**

- **Adhesive (patch)** A self-adhesive, rapid-response probe recommended for all small test-pieces and materials less than 1.0 mm/0.04 in. thick. Attach to the product, test-piece or test-fixture using high-temperature adhesive tape. When attached to a re-usable test-piece or test-fixture, the probe may be coated with powder/paint enabling reliable, repeatable beneath-coating temperature measurements to be made; this is a major advantage when using infra-red heaters as the absorption of radiation, and thus heat, is affected by the coating's color.
- **Bolt-on (washer)** A rapid-response probe normally permanently mounted on a re-usable test-piece or test-fixture. Provides reliable,

repeatable measurements. Attach to the product, test-piece or test-fixture using a bolt or self-tapping screw.

- **Clamp-on** A quick and easy method suitable for ferrous and non-ferrous materials. The product must have a thin, flat surface to ensure good thermal contact.
- **Magnetic** A quick and easy method suitable for ferrous materials. The product must have a flat surface to ensure good thermal contact.
- **Welding/soldering** A rapid-response probe normally mounted permanently on a re-usable test-piece or test-fixture. Provides reliable, repeatable measurements. *Ensure probes are not connected to the logger when they are being welded.*

## Air Measurement

- **Adhesive (patch)** Recommended for use where rapid response is required, but used for air measurement only where clamp-on or magnetic probes cannot be used due to product shape, etc. Secure the cable to the product, test-piece or test-fixture using high-temperature adhesive tape ensuring the probe is in space and able to measure the air temperature.
- **Clamp-on** A quick and easy method suitable for ferrous and non-ferrous materials. The product must have a thin, flat surface to ensure continuing attachment.
- **Magnetic** A quick and easy method suitable for ferrous materials. The product must have a flat surface to ensure continuing attachment.

## Testing Thermocouple Probes

Although thermocouples are generally robust, they can be damaged during handling. To confirm their correct operation after installation, either:

- Set up the system as if to monitor a profile run using hardwired telemetry (see p. 63 for details), and note the temperatures registered by the thermocouples as they are displayed in Insight – *or*
- Use a type-K digital thermometer, attaching each thermocouple in turn to the thermometer's connector – *or*
- With a full set of thermocouples attached to the logger, and the logger connected to the PC, open the Diagnostic section of the Communications Setup dialog in Insight; this shows current probe temperatures (see p. 14 for details).

Proceed as follows.

1. Note readings first at ambient temperature: thermocouples registering no data in Insight, or an open circuit with a digital thermometer (\*OC\* in the

Communications Setup dialog), may be broken. Inconsistent readings may indicate an intermittent short circuit.

2. If a satisfactory ambient reading is recorded, apply heat to the thermocouple-tip via fingers or other heat source. An increased temperature should register:
  - If the reading does not change, the thermocouple is short circuit and must be replaced.
  - If the probe measures air temperature, the cable may have damage which has created a new hot junction.
  - If the thermometer shows a decrease, the thermocouple connections are reversed.
3. Confirm correct operation at 100°C/212°F by placing the thermocouple-tip in freshly-boiled water.
4. Replace any damaged cables.

### ***Care of Thermocouples***

When coiling thermocouple cables for storage, ensure the diameter of the coil is not less than 40 cm (16 in.).

Examine the cables after each profile run, and replace any found to have damaged insulation.

# Running a Temperature Profile

A temperature profile can be acquired by two means:

- **Without telemetry** – After the logger and product have been in the oven, data is downloaded from the logger into the PC to be displayed and analyzed by the Datapaq Insight software.
- **Using hardwired telemetry** – As the logger gathers data from the product inside the oven, this is transmitted directly to the PC by a hardwired connection. The temperature profile can be watched developing as it happens, i.e. in real time. See p. 63.

This chapter describes the stages of obtaining a temperature profile for your process without telemetry – from placing the probes, to downloading the data into the software, ready to be analyzed.

## Overview

It is important to be aware of the key characteristics of the process you will be profiling. These include:

- Line speed.
- Number of oven zones.
- Maximum temperature in each oven zone.
- Number, location and method of attachment of the thermocouple probes.
- The approximate temperature profile which the thermal barrier is expected to experience.
- Height and width restrictions within the oven.

Before the logger is used for the first time with a given PC, you must:

1. **Install** Insight software (p. 13).
2. Establish **communication** between the logger and the computer/software (p. 14).

Before running your product or test-piece, and the logger, through the oven you will use the Insight software to reset the logger, i.e. to prepare it for receiving fresh data. After the logger has been retrieved from the oven, you will use Insight again to download the profile data and save it to disk. The stages are as follows.

1. Choose positions for, and attach, the thermocouple probes (see p. 41).

2. Reset the logger so that its memory is emptied and it is ready to receive fresh data; in the process of doing this you will also be able to set the sample-collection interval, the method used to trigger the start of data collection, and whether to use multiple- or single-run mode, and to check the logger's battery status. *Resetting the logger is not necessary if the logger is in single-run mode (p. 48) and the previous data-collection parameters are to be re-used.*
3. Install the logger in its thermal barrier.
4. Run the instrumented product or test-piece, together with the logger/ barrier, through the oven.
5. If using Smartpaq for quality assurance, check Smartpaq LED for pass/fail (p. 50).
6. If using multiple-run mode (p. 48) and the same data-collection parameters, you may carry out further profile runs up to a maximum of 10.
7. Download the data (from up to 10 multiple runs) from the logger into the Insight software (p. 57).
8. If necessary, set the oven start position within the data (p. 60) and apply thermocouple and/or logger correction factors (p. 60).
9. Add any additional notes that you wish to have recorded with the profile data (p. 61).

After this, Insight can be used to analyze the profile data as required.

*When the MemoryPaq is plugged into the PC and Insight is not running, you will by default be presented with a **popup option to reset the logger or to download data** from it. If you accept one of these options, Insight will run and the operation will start. If you disable the popup feature and wish later to re-enable it, right-click the XL2 icon in the Windows system tray (notification area).*

## Resetting the Data Logger


Resetting the logger using Insight deletes any existing profile-run data stored in the logger, and allows you to modify the data-collection parameters which the logger will use in future. The following describes a **non-telemetry profile run**, i.e. one during which the logger is not connected to the PC, and the data is downloaded to the PC afterwards for analysis. (To reset the logger for a run using telemetry, see p. 63).

It is not necessary to go through the reset procedure if the **previous data-collection parameters are to be re-used** for the next profile run and (when the logger is in multiple-run mode, see p. 48) if data from nine or fewer profile runs is stored in the memory. To start a new profile run, see p. 53. (If the memory is full, the MemoryPaq display flashes '88' and data from one or more profile runs must then be downloaded before a further run can be performed; see p. 57.)

If the logger is **too hot** from the previous run, Insight will (by default) display a warning message – showing the logger's current internal temperature – until it cools; Insight can also be set to prevent reset in these circumstances (this feature is configurable; see p. 26).

The MemoryPaq can be reset with or without a **Transducer Interface** attached.

If a Transducer Interface is attached, its internal temperature will be registered (which may trigger warnings or prevent reset, see p. 26) and will be displayed in the Logger Reset dialog.

The procedure described here uses the Insight software's **Logger Reset dialog**. If you are less sure of the process, you can instead use the Logger Reset Wizard to guide you, step-by-step, through this stage of running a profile: click  on the Insight toolbar, or select Tools > Wizards from the menu.

Any data stored in the logger but not yet analyzed must be **downloaded** before proceeding, as resetting the logger will **permanently erase all data** stored in it. If the reset process is started on a logger which contains data from a previous run which has not been downloaded, a warning message will show this (and the logger-status red LED will be flashing every 5 s).


To perform a **hardware reset** (i.e. without using Insight) and set the factory defaults (sample interval 5 s, trigger mode plug-and-go), see p. 26. A hardware reset when the logger is in multiple-run mode (p. 48) will not delete any existing profile-run data from the logger memory, and thus cannot be used if the logger memory contains 10 profile runs (whether or not they have been downloaded).

1. Use the communications lead supplied to connect the logger to a free USB port on the PC.

To minimize communications problems: a) connect the lead first to the PC and then to the logger; b) always use the same USB port – the one which was first used to set up communications (p. 14).

The red LED on the logger should flash five times to confirm that connection has been made between the logger and a powered-up PC (if it does not, see 'Communications Setup', p. 14).

2. If Insight is not running, you will by default be presented with a popup option to reset the logger or to download data from it; select the option to reset the logger, and Insight will run and the operation will start. If Insight is

already running or the popup feature has been disabled (see p. 46), open the Logger Reset dialog (click  on the Insight toolbar, or press function key F2, or select Logger > Reset from the menu bar) and specify your reset options as follows.

**Sample Interval** Set the time which is to elapse between each set (sample) of data points (one data point for each probe) that the logger will collect. This sample interval is normally selected to ensure that 800–1,000 samples are stored over the whole run. Thus, sample interval is the profile duration in seconds divided by the number of samples required. The shorter the sample interval the better you will be able to record short-term variations in your temperature regime – but the total recording time available to you will be reduced, and the data will take longer to download to the PC after the run.

**Run Mode** Select whether to use single-run or multiple-run mode.

*In single-run mode:*

- Data must be downloaded after every run.
- When starting the next profile run, the data held in the logger will be deleted automatically (this is prevented if the data has not yet been downloaded), so there is no need to reset the logger unless you wish to change the data-collection parameters.

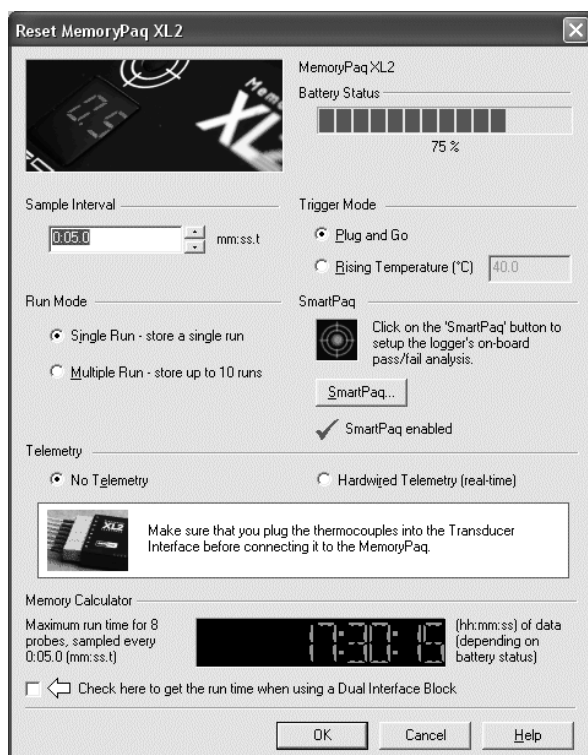
*In multiple-run mode:*

- The XL2 can collect data from up to 10 profile runs before it needs to be downloaded (p. 57).
- After 10 profile runs have been performed, the logger must be reset using Insight (see below) in order to delete data from the logger and empty it for further runs.
- Individual profile runs can be downloaded from the logger at any time, but this does not free up any space in the logger's memory until the whole memory is emptied by performing a reset using Insight.
- Each multiple run will be performed using the same data-collection parameters, until the logger is reset.

**Telemetry** Select 'No Telemetry'.

**Memory Calculator** Calculates the maximum time for which the logger can collect data, given the sample interval which has been set and assuming that eight probes are in use, with a single Transducer Interface. When a Dual Interface Block and two Transducer Interfaces are used, check the option provided in the dialog: this calculates a revised time, assuming that 16 probes are in use (i.e. the time will be halved). If multiple runs are to be performed before downloading data, the calculated data-collection time must be enough to cover the total time for those runs. See p. 23 for details of the logger's memory capacity. The data-collection time may be further

limited by the level of battery charge and by the performance of the thermal barrier used.



*The **Reset** dialog for the XL2 logger.*

**Battery Status** The charge indicator gives both the current percentage of full charge held by the logger battery, and a color-coded report:

- GREEN** Sufficient charge to perform a run.
- YELLOW** May be enough charge for a run, but battery getting low.
- RED** Insufficient battery charge: recharge immediately.

*The battery charge level will not be displayed if the logger is on charge: disconnect the charger to verify battery status.*

NiMH batteries discharge slowly even when not in use and will need charging if left for more than three weeks (see p. 23).

If in any doubt, abort the procedure by clicking 'Cancel', and recharge the logger.

**Trigger Mode** Select here a means to start the logger recording data.

**Plug-and-Go** Data-recording starts immediately the reset is complete and a Transducer Interface (or Dual Interface Block) is attached to the MemoryPaq.

**Rising Temperature** Data-recording starts when the temperature of any probe rises to the specified value.

**SmartPaq** For instant quality assurance, click the button to enable or disable SmartPaq, or to create or edit the pass/fail criteria (see below for details). The current status (enabled/disabled) is shown.

**Logger Temperature** If a Transducer Interface is attached, its internal temperature is shown, updated every 5 s.

3. After clicking OK, the logger is reset and a message box confirms the sample interval and trigger mode you have set.
4. Disconnect the communications lead from the logger; the logger-status LEDs flash red and green together to confirm logger reset. and the sample interval shows on the logger's display.

*If a Transducer Interface (with or without Dual Interface Block) has been attached to the MemoryPaq during reset, and if the trigger mode is plug-and-go, **data-recording then starts immediately** (see below for important warnings about thermocouple connection); after reset, the logger's alphanumeric display briefly shows 't1' if one Transducer Interface is attached, 't2' if two are attached.*

## Using SmartPaq

SmartPaq provides instant pass/fail quality assurance on removal of the system from the oven. There are two simple stages:

1. As part of the reset procedure (p. 46), **pre-program the logger** with your process's pass/fail criteria (see below).
2. When a profile run is stopped (i.e. when the MemoryPaq is disconnected from the Transducer Interface or Dual Interface Block), the logger calculates the result: snaking lights show on the MemoryPaq's display to indicate calculation in progress, and then the logger's SmartPaq LED shows the outcome – **green** for pass, **red** for fail.



The SmartPaq LED.

SmartPaq calculations will be performed on data from **all the thermocouples** that are specified in the SmartPaq setup (see below).

The SmartPaq result will be a **fail** if:

- **One or more of the chosen parameters** (see below) is outside the limits specified for any of the thermocouples .
- Data from any of the specified thermocouples contains **invalid data** (e.g. open circuit, see p. 67).

## SmartPaq Setup

Parameters for the SmartPaq calculations are programmed into the logger as part of the reset procedure (p. 46). In Insight's Logger Reset dialog, click the SmartPaq button to open the SmartPaq Setup dialog and specify or edit your parameters as follows.

For identification purposes, you may enter a **description** for your new set of parameters. When you have defined (or edited) them, click **Save As** to save these (as a SmartPaq parameters file, \*.PFP) for future use; or click **Open** to use a previously-saved set. The description is included in the report of the profile run which you can print after downloading the data (see p. 61).

You can specify parameters and limits for any combination of:

- Datapaq Value (one cure schedule).
- Time at Temperature (up to three thresholds with Oven Tracker Professional, one threshold with Over Tracker Basic).
- Maximum Temperature.

*For **details of these analysis modes** as used within Insight, select 'Data Analysis' in the online Help system (on Insight's menu bar, select Help > Contents).*

Select the analyses which are to form part of the SmartPaq calculation.

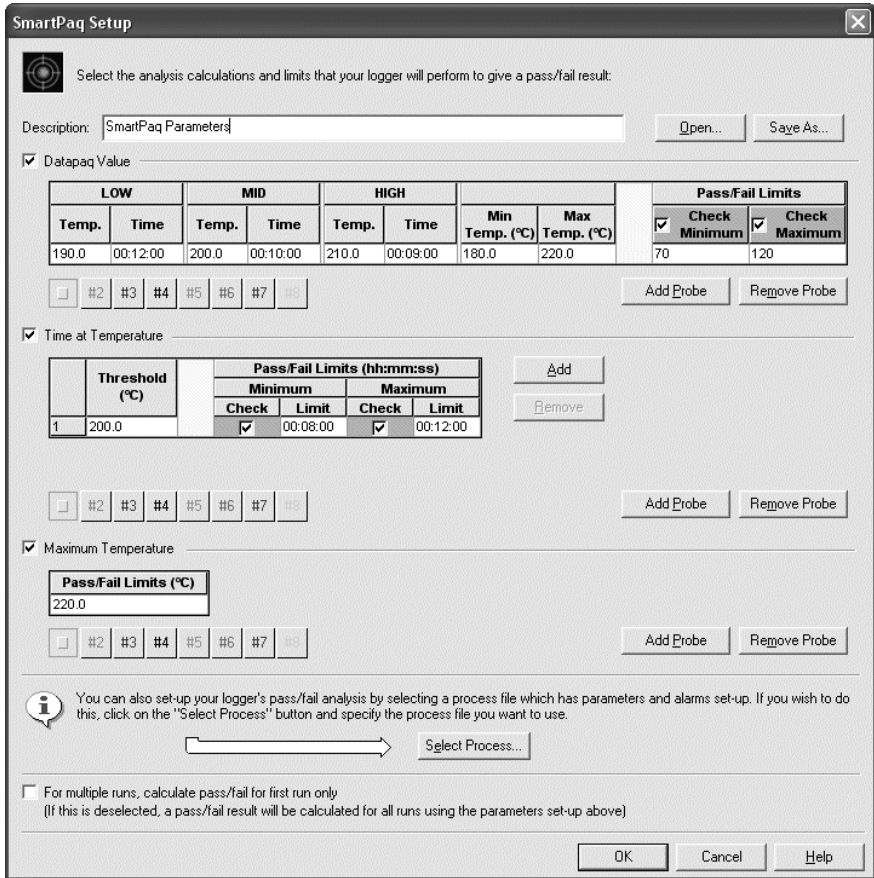
**NB Failure to pass any one of the selected analyses will cause an overall fail in the SmartPaq calculation** (see above).

### Datapaq Value

Enter **cure-schedule data** to suit your process, as recommended by your coating manufacturer:

- Temperature and time data for **three cure options**.
- **Minimum and maximum** permitted temperatures for successful cure.

Select whether to test the calculated Datapaq Value against **minimum and/or maximum values**, and enter those values (for guidance, see Data Analysis > Datapaq Value in Insight’s online Help system). (See also ‘Process File’, below.)



The *SmartPaq Setup* dialog.

## Time at Temperature

Enter data for **temperature thresholds** (up to three thresholds with Oven Tracker Professional, one threshold with Over Tracker Basic) and whether to test the times spent above those temperatures against **minimum and/or maximum permitted times**. By default there will be one threshold temperature, which will be the value setup for the mid cure option in Datapaq Value. Click to **add** or **remove** thresholds from the list. (See also ‘Process File’, below.)

## Maximum Temperature

Enter a **maximum permitted temperature**. By default, the value will be the maximum temperature entered for Datapaq Value calculations. (See also 'Process File', below.)

## Probe Selection

Probe selections can be set separately for each of the SmartPaq analyses.

Click on **probe numbers** to exclude them from the SmartPaq calculations. Click to **add** or **remove** probes as necessary to match your setup. (Insight remembers your selections, so it not necessary to repeat this unless your setup changes.)

If the Transducer Interface(s) used contain more probes than are shown in this dialog, the additional probes will be included in the SmartPaq calculation.

## Process File

If you have already setup a process file in Insight which contains the parameters you require for Datapaq Value, Time at Temperature or Maximum/Minimum Temperature, click **Select Process** to browse to the process file. The relevant parameters from that process file will then be entered automatically in the SmartPaq Setup dialog.

*For **details of process files** as used within Insight, select 'Process Files: Oven, Recipe, Product' in the online Help system (on Insight's menu bar, select Help > Contents).*

## Multiple Runs

For multiple runs (p. 48), select whether the SmartPaq pass/fail calculation will be carried out for all runs or for only the first run.

# Installing the Logger in the Thermal Barrier, and Starting the Logger

*Ensure the **thermal barrier has cooled** sufficiently since its last use. Before using a new barrier for the first time, or if you suspect a barrier has absorbed **moisture**, you should run it once through your process without the logger to remove the moisture; see p. 29.*

*For correct selection of a suitable barrier, see p. 33.*

1. Plug the thermocouples into the logger's numbered sockets. If you are using a process file, ensure that the probe/socket numbers on the logger correspond to those used to define probe numbers and locations in that file (see the Insight software for an introduction to process files: press function key F1, or select Help > Contents from the menu bar, and click the section 'Process Files: Oven, Recipe, Product'). It is not necessary to have thermocouples attached to every socket.
2. If not attached already, **start data-collection by attaching the MemoryPaq to the Transducer Interface** (or to the Dual Interface Block if used). After connecting them, the logger's display briefly shows 't1' if one Transducer Interface is attached, 't2' if two are attached.

### WARNING

All the thermocouples which are to be used **must** be plugged into the Transducer Interface **before** the Transducer Interface is attached to the MemoryPaq. If any thermocouples are plugged in after the MemoryPaq has been attached, **data from those thermocouples will be ignored.**

Similarly, if a **Dual Interface Block** is fitted, either one or two Transducer Interfaces (each with any number of thermocouples connected) may be attached to it – but, if two Transducer Interfaces are used, **both** must be attached to the Dual Interface Block **before** the MemoryPaq is plugged into it.

If a logger reset has not been carried out since the previous profile run, data-collection parameters from the previous reset will be used. If the trigger mode is **plug-and-go**, data-recording starts when the logger units are connected together, and the green logger-status LED starts flashing at the sample interval. If the trigger mode is **rising temperature**, data-recording will start when the temperature of any probe reaches the value specified during reset.

*Data-recording cannot start until the **logger has cooled** sufficiently from the previous run. If it is over 45°C/113°F, error 'E1' will show on the logger's display (see p. 21).*

*If the MemoryPaq display flashes '88', the memory is full and/or the maximum of 10 profile runs has been stored. Data-recording will then not start, and data from one or more profile runs must be downloaded before a further run can be performed; see p. 57.*

3. Ensure the barrier's mating surfaces are clean and undamaged. A good seal between barrier and thermocouple cables is essential if the logger is to be protected. Put the logger in place in the barrier (within the heatsink if used), laying the thermocouple cables across the sealing material to exit the barrier at the cutout, ensuring they are side by side and not crossing each other.

4. Fit the lid, ensuring a good seal around the thermocouple cables. Secure the lid's catches with the locking pins, if fitted.

*The Tracker system is designed to pass through the oven after the product has been coated. Any coating which has become attached to the probes during a previous run will influence the measurements, and it must be removed before the next run starts.*

## Placing the System in the Oven

### SAFETY

*Discuss the application of the Tracker system with your Health and Safety officer.  
Wear appropriate protective clothing.  
If appropriate, use lifting equipment when loading the system.*

Load the test piece or product so that it enters the oven before the thermal barrier and logger.

*Do not lift the data logger by the thermocouple cables. This will damage the cables and connectors.*

Check the **minimum height and width through the process** to ensure the clearance for the system and thermocouple probes is adequate. If necessary, secure the thermocouple cables using high-temperature tape ensuring they do not get too close to heating elements.

## Removing the System from the Oven

### SAFETY

*The thermal barrier – and the logger inside it – will be **hot**. Use protective gloves.  
If appropriate, use lifting equipment when recovering the system.*

**Recover the system from the oven as soon as the run is over.** 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 it is safe to do so.

*Failure to remove the logger from the hot thermal barrier could damage the logger.*

**Stop data-collection** by separating the MemoryPaq from the Transducer Interface. A slowly-flashing red LED indicates that the logger holds data that has not yet been downloaded to the PC.

It is normally convenient to leave the thermocouple probes attached to the Transducer Interface.

Leave the thermal barrier and heatsink in the open to cool to ambient temperature. Cooling overnight is usually sufficient, but an additional barrier should be purchased if insufficient time is available to allow the barrier to cool between runs.

*Placing a hot thermal barrier directly onto a cold surface may cause the barrier's case to distort due to the different cooling rates of the surfaces. Place the hot barrier on a Datapaq barrier stand to give optimum cooling and protection from distortion. Alternatively, stand the hot barrier on spacers, an insulating fiber blanket, or refractory material.*

*Datapaq will not be liable for damage caused by distortion due to incorrect handling of a barrier while cooling.*

## **Examining the System for Damage**

Once cool, examine the thermal barrier, heatsink (if used) and thermocouples for damage.

Check the barrier's **seals and closing mechanism**, and rectify any damage before further use. Some sealing catches are designed to be set easily by hand, and may require some adjustment after the first four or five runs.


Examine the heatsink's **thermometer strip**. If the temperature has exceeded 77°C/171°F allow the heatsink to cool to around 15°C/60°F and then place it in a freezer at -20°C/-5°F overnight; this ensures the phase-change material crystallizes. After freezing, allow the heatsink to return to room temperature. If the thermometer strip has recorded a temperature greater than 77°C/171°F, peel it off and replace it.

**If the heatsink phase-change material leaks**, contact Datapaq. 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 off any material that has leaked onto the surface of the barrier.

Store the thermal barrier in a dry environment to prevent its insulation from absorbing any water (see p. 29).

Examine the **thermocouple cables**, and replace any found to have damaged insulation.


# Downloading Data

*The procedure described here uses the Insight software's Logger Download dialog. If you are less sure of the process, you can instead use the Logger Download Wizard to guide you, step-by-step, through this stage of running a profile: click  on the Insight toolbar, or select Tools > Wizards from the menu.*

1. Use the communications lead supplied to connect the logger to a free USB port on the PC.

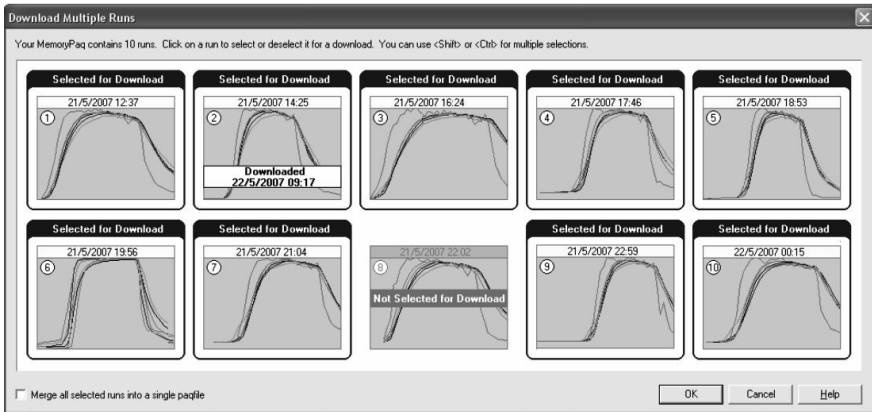
*To minimize communications problems: a) connect the lead first to the PC and then to the logger; b) always use the same USB port – the one which was first used to set up communications (p. 14).*

The red LED on the logger should flash five times to confirm that the connection between the communications lead and the logger has been made (if it does not, see 'Communications Setup', p. 14).

2. If Insight is not running, you will by default be presented with a popup option to reset the logger or to download data from it; select the option to download data, and Insight will run and the operation will start. If the popup feature has been disabled (see p. 46), open the Logger Download dialog (click  on the toolbar, or press function key F3, or select Logger > Download from the menu bar).
3. If the logger holds data from **multiple runs**, Insight displays a numbered thumbnail of each profile, with data-collection time shown (Oven Tracker Professional only). Any profiles whose data has already been downloaded are marked in the display. By default, all profiles will be selected for download, unless they contain fewer than 10 data-points. Click on thumbnails to deselect any you wish not to download. You may select to **Merge all selected runs into a single paqfile**: this will combine the data in a single paqfile (for an explanation of merging, see Menu Functions > File > Utilities in the online Help system). Click 'OK' to start downloading the selected profile data; click 'Cancel' to abort the downloads.

*Downloading individual runs from the logger does **not** delete those runs from memory or clear space for further runs to be added. The only way to delete data from the logger's memory is to perform a reset using Insight (p. 46), and this deletes all the profile-run data stored in the logger.*

*Individual runs can be selected for download in Oven Tracker Professional only. In **Oven Tracker Basic**, all profiles in memory are downloaded on starting a download.*



**Downloading data from multiple profile runs** stored in the XL2 logger (Oven Tracker Professional only): here, all profiles except no. 8 are selected for download; profile no. 2 has already been downloaded, but will now be downloaded again; the profiles will not be merged.

4. Wait while the data is downloaded to the PC.

*If you see the message*

**Logger stopped due to going over temperature**

*the data logger's maximum-permitted internal temperature has been exceeded, and it may have suffered damage. The reason for the excessive temperature – which may be the result of process operational problems or the use of an inappropriate thermal barrier – must be resolved before further profile runs take place; contact Datapaq for advice.*

*A warning message will also be shown if the logger has stopped recording data due to a **low battery**, and (if the warning is enabled, see below) when probes are **open circuit**.*

*In all cases, data recorded up to the point of error will have been preserved.*

*For **recommended actions** to take in response to error messages, see p. 67.*

*To disable these alarms, select **Tools > Options > Run Alarms**.*

5. In Oven Tracker Professional, the Select Process dialog then appears for each profile, as it downloads, in order that you may choose a process file to apply to the results; if the process file and its components have been given names, these are shown when the process file is selected (in Oven Tracker Basic, the selected process file will be applied to all the profiles which are downloaded together). If multiple runs are being merged, a single selected process file will be applied to the single merged pafile created. Click 'No Process' if you do not want to apply a process file. (A process file allows

you to see the temperature profile in relation to the oven zones as the profile appears on screen during the run. See the Insight software for an introduction to process files: press function key F1, or select Help > Contents from the menu bar, and click the section 'Process Files: Oven, Recipe, Product'.)

*If you will normally not wish to apply a process file to the results, you can opt not to have the Select Process dialog displayed immediately after a download (from the menu bar, select Tools > Options > Process File); a process file may still be applied subsequently.*

6. The newly downloaded data then appears on screen and can be displayed (numerically and graphically), analyzed and printed as you wish; see Insight's online Help system. If multiple runs have been downloaded, each temperature profile will be displayed as a new tab in Insight, unless you chose to merge the profiles during download (see above). Save the data as a 'paqfile' (select File > Save or Save As).

## Open Circuits

An open circuit can occur during a profile run if a thermocouple becomes damaged. The logger will then continue sampling on that channel, but, by default, a warning – giving the relevant probe number – will be shown when the data is downloaded (see above). To disable the alarm, select Tools > Options > Run Alarms.

*The means of proceeding to the **next profile run** after a logger download depend on the contents of the logger memory, on whether the logger is in multiple- or single-run mode (p. 48), and on whether you wish to change the data-collection parameters.*

*Logger in **multiple-run mode**:*

- *If the logger memory contains **nine or fewer profile runs** (whether or not they have been downloaded), **data-recording for the next run can be started simply by attaching the MemoryPaq to the Transducer Interface** (or to the Dual Interface Block if used) – see p. 53; the previous data-collection parameters will be used.*
- *If the logger memory contains **10 profile runs** (whether or not they have been downloaded), **a new run cannot be started until the logger memory has been emptied by resetting using Insight** (p. 46).*

cont. >>

Logger in **single-run mode**:

- When starting the next profile run, the data held in the logger will be deleted automatically (this is prevented if the data has not yet been downloaded), so there is no need to reset the logger unless you wish to change the data-collection parameters.

For both **multiple- and single-run modes**:

- To start a new run with **different data-collection parameters**, reset the logger – either using Insight (p. 46), or, for the factory default parameters, by hardware reset (p. 26). Using a hardware reset in multiple-run mode will not delete any existing profile-run data from the logger memory.

## Preparing the Data for Analysis

For full details of Insight's powerful analysis capabilities, see the online Help system: on Insight's menu bar, select Help > Contents > Data Analysis. Before starting full analysis of the downloaded data, it may be advisable to:

- Apply a process file (see p. 58).
- Specify the oven start position in the data.
- Apply thermocouple and/or logger correction factors to the data.
- Record any notes specific to the profile run.

### Specifying Oven Start

If you have not applied a process file to the data during download (see above), or if the process file you applied did not specify that the **oven start position** be adjusted, you may want to adjust the oven start position now: from the menu bar, select Process > Adjust Oven Start, or use the right-click menu.

This can be valuable as it permits different paqfiles, i.e. data from different temperature profile runs, to be compared with each other. If you do not wish to adjust the oven start at this point, you may still do so at any time subsequently.

*For an explanation of oven start, and how to adjust it, click Help in the Adjust Oven Start dialog.*

### Thermocouple and Logger Correction Factors

In Oven Tracker Professional it is possible to increase accuracy by using calibration data for the logger and thermocouples to establish correction factors. If correction factors are known for a range of temperature values, and

if a linear relationship is assumed between adjacent temperature values, appropriate corrections can then be applied to all data within the calibrated temperature range. Insight stores these correction factors in a 'correction factor file', and correction is achieved simply by applying this file to the data.

*For details of the creation and use of correction factor files, see the topic 'Correction Factors' in Insight's online Help system.*

## **Storing Notes and Printing a Report**

To use Insight to store any **notes or photos** which you may wish to associate with the profile-run data, select Edit > Notes.

To select options for **printing a customized report** of the profile-run data and its analysis results, select File > Print Options.

## **Logger Defaults and Details**

Defaults for several of the logger's variables can be set using Insight. Select Tools > Options > Logger (and click 'Advanced' for some features).

- Use of warning message if the logger is too hot.
- Ability to disable reset if the logger is too hot.
- Maximum temperature permitted if reset is to be allowed (default 45°C/ 113°F).
- Frequency of the local electricity supply.
- Ability to download and display pre-trigger data (see below).
- Ability to download and display data for the logger's internal temperature which is gathered while it is logging.

On this Logger tab of the Global Options dialog you can also find the **model** and **identification number** of the logger, and enter **calibration** information and be warned when re-calibration is due.

*For full details of using the dialog, see Insight's online Help.*

## **Pre-trigger Data**

If a temperature trigger (see p. 49) is used to start data-logging, the logger also records data before this point is reached. The most-recent c. 100 of these data-points are retained by the logger. You can download this pre-trigger data by setting a default (see above), and it will then form part of the temperature profile, falling before the zero time point.

If the logger does not reach the temperature required to start data-logging, Insight will always download the pre-trigger data, in order to aid the user in determining why triggering did not occur.

*For further features of the Insight software – particularly data analysis and the use of process files – see the online Help system (on Insight’s menu bar, select Help > Contents).*

# Using Hardwired Telemetry

In addition to the standard off-line analysis, real-time analysis by **hardwired telemetry** is possible with Insight software when used with an intermittent or periodic oven (a batch process).

Thus, with thermocouples trailing from the oven and attached to the logger outside the oven, data being gathered by the logger is transmitted via the communications lead directly to the PC, and the temperature profile can be watched developing in the Insight software as data is received, i.e. in real time.

*Telemetry is not available with Insight Lite software.*

## Running a Temperature Profile Using Hardwired Telemetry

By following the procedure in this chapter, you will use the Logger Reset and Logger Download dialogs to run a temperature profile using hardwired telemetry.

Running a profile in real time is performed in essentially the same way as a normal (non-telemetry) run (see p. 45), but, in addition:

- The **communications lead** is left attached to the logger.
- A **process file** can be applied before the run starts in order that the data can be understood more readily as it appears on screen.
- While the run is in progress, the **real-time display** of incoming data can be customized as preferred, and the logger's status can be checked.

Multiple-run mode (p. 48) and Smartpaq (p. 50) are not available during hardwired telemetry.

### **Resetting and Starting the Logger When Using Hardwired Telemetry**

The logger is reset and started exactly as for a normal (non-telemetry) profile run (see p. 46), except that:

- In the Reset dialog, select **Hardwired Telemetry**. Multiple-run mode and Smartpaq are then not available.

- After completing your selections in the Reset dialog, **leave the communications lead attached** to the logger and PC.
- The **Select Process** dialog then appears in order that you may choose a process file to apply to the results. If the process file and its components have been given names, these are shown when the process file is selected in the list. Click 'No Process' if you do not want to apply a process file. (A process file allows you to see the temperature profile in relation to the oven zones as the profile appears on screen during the run. See the Insight software for an introduction to process files: press function key F1, or select Help > Contents from the menu bar, and click the section 'Process Files: Oven, Recipe, Product'.)
- There will normally be no need to use a thermal barrier to protect the logger.

### **WARNING**

*All the thermocouples which are to be used **must** be plugged into the Transducer Interface **before** the Transducer Interface is attached to the MemoryPaq. If any thermocouples are plugged in after the MemoryPaq has been attached, **data from those thermocouples will be ignored.***

*Similarly, if a **Dual Interface Block** is fitted, either one or two Transducer Interfaces (each with any number of thermocouples connected) may be attached to it – but, if two Transducer Interfaces are used, **both** must be attached to the Dual Interface Block **before** the MemoryPaq is plugged into it. If the second Transducer Interface is attached after the MemoryPaq is connected, data from thermocouples plugged into the second Transducer Interface will be ignored.*

You may specify that a **password** is required when an attempt is made to close Insight while a real-time telemetry run is in progress: select Tools > Options > General from the menu bar.

If the **logger's memory becomes full** during hard-wired data-collection, the logger will continue gathering data, but excess data will be passed to the PC and not stored by the logger. When the profile run is complete, the full data can then be saved as a paqfile within Insight (see below). When the logger's memory is filled, the MemoryPaq display flashes '88'.

## **Real-time Display During the Run**

After the first few data packets have been received, the data starts to be displayed in the Graph and Analysis Windows, scrolling in real time as new data is received. You may change the way the data is displayed with the Axes tab of the Graph Options dialog (from the right-click menu, or from the main menu select View > Graph Options): under Telemetry, specify how much of the recently received data is displayed, and whether you wish to see only a certain temperature (y-axis) range, centered on a the latest data.

You may **zoom** the display as when viewing a paqfile (see the online Help system), except that:

- Double-clicking on the graph (or selecting Real Time Zoom from the View menu or right-click menu) shows only the most recently received portion of the data on the scrolling graph (see above).
- Saved zoom modes are not available.

If the **y-axis** is not set to be centered (see above), the default y-axis zoom changes as more data is received, in order to accommodate all received data.

To **move the graph** across the viewing area, hold Shift and drag the mouse pointer.

You may overlay one or more **tolerance curves** on the graph to compare with the data as it is being received (select View > Overlay). Other paqfiles cannot be overlaid.

You may adjust the **oven start** position while a real-time run is in progress (select Process > Adjust Oven Start, or use the right-click menu).

Calculations shown in the **Analysis Window** for the chosen data analysis mode update continuously as new data is received. As for non-real-time runs, calculations are performed only on the currently zoomed area shown on the graph. However, if the graph is scrolling and showing just the most recently received portion of the results, the analysis calculations will be performed as if on the full zoom view.

If you wish to **view another paqfile** while the logger is in listen mode, i.e. while data is being received and viewed in real time, you must first stop real time mode (see 'Ending the Run', below).

## **Ending the Run**

To **end or pause data-collection** while a telemetry run is still in progress, select Logger > Stop Real Time Mode. Data then continues to be collected by the logger, but it is no longer received in real time by Insight (download from the logger after the run is finished to retrieve the full data). The graphical and numerical data received up to that point remain on screen, available for viewing and analysis, and can be saved as a paqfile.

While the logger is still operating, you may **resume the collection of data** by Insight: select Logger > Logger Listen Mode. This second bout (and any subsequent bouts) of data-collection can also be ended and saved as a separate paqfile, as above.

If **Autosave** is enabled (select Tools > Options > General), the data being gathered is automatically saved periodically during a telemetry run. If the system fails during the run, the last-autosaved version of the data is displayed

automatically when Insight is next run, and you may then choose to save it as a paqfile.

When the run is complete, ensure that data received by Insight has been **saved as a paqfile**. If you wish, you may download the data held in the logger (p. 57), though it should normally be adequate simply to save, as a new paqfile, the data already received.

# Troubleshooting

## Logger Communications Problems

- **Communications lead not fully inserted** – Check correct sockets are being used.
- **Damaged communications lead or connectors** – Check for breaks and other damage; replace the lead.
- **Batteries not charged** – Recharge the batteries, ensuring the charging LEDs are illuminated (see p. 21).
- Try a **hardware reset** using the default reset parameters (see p. 26).

## Logger Download Error Messages

Error Message	Action
<b>There are insufficient readings in the logger</b>	Check trigger set point (time or temperature). Check logger's battery for charge. Check date/time settings on computer. Check probes and their connections. Reset logger and test probes (see 'Logger Diagnostics', below).
<b>Logger stopped due to going over temperature</b>	The logger's maximum-permitted internal temperature has been exceeded and it may have suffered serious damage: contact Datapaq for advice.
<b>Logger stopped due to low battery</b>	Replace or recharge the battery as appropriate, then repeat the profile run.
<b>Logger memory full</b>	Data collection may have stopped before the run was completed: check the data collection period and sample interval before resetting the logger for another run (see 'Resetting the Data Logger', p. 46).

## Checking the Data

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\*    Telemetry data not received.

- \*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 running data logger. Typical causes of invalid or interrupted data are:

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

Readings which are inconsistent with those of other probes may be caused by a short circuit (see 'Logger Diagnostics', below). The probe concerned must be replaced.

## Logger Diagnostics

Running the data logger diagnostics (p. 14) provides information on the status of the logger and the means to test the thermocouple probes. Short circuits and open circuits may be revealed: these are sometimes intermittent, and can be a function of temperature and/or rate of change of temperature, or caused by bending the probe cable. See p. 43 for this and other means of testing the thermocouples.

## Datapaq Service Department

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

# INDEX

- Barrier – See Thermal barrier
- Cable – See Communications lead, Thermocouple probe
- Case 34
- CoilPaq 11
- Communications lead 67
- Communications setup – See Insight
- Computer
  - specification, minimum 13
  - USB setup and drivers 14
- Data
  - invalid 67
  - pre-trigger 61
  - raw 67
  - View Data 67
- Data logger
  - battery 23
  - battery charging 19, 23
  - battery life 25
  - battery status 21, 49
  - calibration 27, 61
  - defaults 61
  - diagnostics 68
  - downloading data 57, 67
  - Dual Interface Block 22
  - LEDs 20
  - memory calculator 48
  - memory capacity 23
  - MemoryPaq 17
  - power-off, auto 24
  - reset for telemetry 63
  - reset, hardware 26
  - reset with Insight 46
  - sample interval 48
  - specifications 19
  - status LEDs 20
  - temperature, internal 16, 47, 61
  - Transducer Interface 17
  - trigger mode 49
- Electricity supply, frequency 16
- Emergency procedures 37
- Error messages 47, 58, 67
- First-aid procedures 37
- Heatsink – See Thermal barrier
- Insight 13
  - analysis 51, 60
  - communication problems 15, 67
  - communications setup 14
  - correction factors 60
  - Datapaq Value 51
  - Help system 14
  - installing 13
  - logger compatibility 13
  - printed report 61
  - process file 53, 54, 58, 59
  - real-time display 64
  - removal 14
  - shortcut keys 14, 16
  - SmartPaq 50
  - uninstalling 14
  - upgrading 14
- Lead – See Communications lead
- Logger – See Data logger
- Open circuit 67, 68
- Oven start position 60
- PC – See Computer
- Probe – See Thermocouple probe
- Process file – See Insight
- PTFE warning 36
- Sample interval – See Data logger
- Short circuit 68
- Software – See Insight
- StenterPaq 11
- Telemetry 63
- Temperature profile
  - erratic 68
  - running without telemetry 45
  - running with telemetry 63
- Thermal barrier 29, 56
  - heatsink 29, 55, 56
  - installing logger in 53
  - selecting 33
- Thermocouple probe 35
  - attachment 42
  - care 44
  - location 41
  - problems 67
  - PTFE 36
  - testing 43

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