# Temperature Uniformity Monitoring: Composite Curing Oven

## Challenge

Help a leading supplier of advanced composite materials measure the temperature uniformity of curing ovens, allowing them to get up and running quickly and optimize their cure cycle

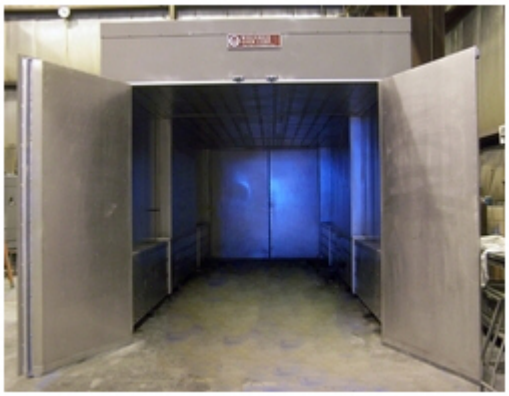
## Solution

Use Data Translation's high-accuracy DT9871 TEMPpoint instrument and Measure Foundry software to monitor temperature of 48 embedded thermocouples from two curing ovens, log results, and optimize the curing process.

## Results

- By providing high-accuracy measurements from up to 48 thermocouples, the TEMPpoint instrument allowed precise characterization of temperature uniformity within the curing ovens.
- TEMPpoints robustness allowed continuous and reliable process monitoring over the curing temperature range and curing cycle.
- The Instrument Pak version of Measure Foundry allowed rapid customization of the ready-to-measure TEMPpoint application, allowing the customer to get up and running quickly, and to optimize the curing cycle.

New materials have played a key role in technological advances throughout human history. Advanced composites are among today's miracle materials. Their remarkable strength-to-weight ratio has led to a number of breakthrough products – from aircraft to bicycles to armor.



When developing composite materials, manufacturers must carefully monitor and control the curing cycle - the process by which the substrate and resin are bonded together (cured) to form the composite material. In this process, large, industrial curing ovens are used to heat the composite material to the proper curing temperature. The size of a two-car garage, these curing ovens allow for batch processing, where materials are loaded onto rolling carts, positioned in the oven, cured, and then rolled out. Characterizing and optimizing the curing cycle is critical in controlling the final properties of the composite material.

**Challenge:**
A leading supplier of advanced composite materials was developing a new composite material and needed to get two, large curing ovens up and running to get their product to market quickly. Temperature uniformity was considered the key measurement requirement when evaluating the curing process.

The customer needed a solution that provided precise temperature measurements from up to 24 J-type thermocouples within each curing oven; each thermocouple would be embedded directly into the composite material. The measurement device needed to be robust enough to monitor these inputs continuously at up to 400 degrees F during the
4-hour curing cycle.

Due to time-to-market requirements, the customer needed a solution that allowed rapid implementation. In addition, the customer wanted an application program that was easy to develop and use and that provided the following features:

- Generated a 3D map of temperature versus time
- Allowed only engineers to access critical set-up parameters
- Gave operators the ability to start and stop the monitoring process with a single mouse click

## Solution

The customer selected the DT9871 TEMPpoint instrument to measure the temperature uniformity of the composite material within the curing ovens. The TEMPpoint instrument proved to be an excellent choice for this application by providing a cost-effective solution with the following key benefits:

### Easy to Use

TEMPpoint includes:

Ready-to-measure TEMPpoint application, developed using Measure Foundry, for displaying and logging temperature data

Easy-access jacks for connecting thermocouples

A standard USB connector and cable for connecting to a laptop

### Easy to Customize

The TEMPpoint application is easy to customize:

The source code for the TEMPpoint application is provided

The Instrument Pak version of Measure Foundry allows users to modify the TEMPpoint application easily

Users can modify the application by dragging and dropping components onto a form and double-clicking each one to configure its property pages. When finished, users press a button to compile and run the application. Customizing an application has never been easier.

## Solution

Typically, lower-cost temperature instruments, designed for ease-of-use, provided only one or two channels – hardly enough to monitor temperature uniformity. These instruments also often lacked the accuracy required for precise measurements as well as the ability to record temperatures over time. Temperature instruments with sufficient channel count, however, were often very large, cumbersome to use, expensive, inaccurate, or all of the above.

The TEMPpoint instrument proved to be an excellent choice for this application by providing a cost-effective solution with the following key benefits:

**Easy to Use**

TEMPpoint includes:

- A ready-to-measure application that displays temperature and logs data to disk.
- Easy-access jacks for connecting thermocouples.
- A standard USB connector and cable for connecting to a laptop.
- Small, rugged enclosure making it easy to transport and ship

**Easy to Customize**

- The TEMPpoint application is easy to customize:
- The source code for the TEMPpoint application is provided
- The Instrument Pak version of Measure Foundry allows users to modify the TEMPpoint application easily
- Users can modify the application by dragging and dropping components onto a form and double-clicking each one to configure its property pages. When finished, users press a button to compile and run the application. Customizing an application has never been easier.

## High-Accuracy

TEMPpoint provides:

- Up to 48 separate thermocouple inputs - mix and match B, E, J, K, N, R, S, and/or T thermocouples as well as voltage inputs.
- No multiplexing and 1000 V galvanic isolation to eliminate cross-talk
- 24-bit Delta-Sigma A/D converters for the highest resolution (1 part in 16 million)
- An A/D converter for each channel
- A CJC for each channel to make TEMPpoint more accurate and more immune to temperature variations both inside and outside the instrument
- Built-in anti-aliasing filters to reject 50 Hz and 60 Hz power line frequencies
- 150 dB common-mode rejection

## Robust

- TEMPpoint was designed with robustness from component-selection up, including:
- 48 parallel instrument architecture for component redundancy in industrial, process monitoring applications
- 1000 V isolation to protect the instrument from the environment and to avoid down-time

**Results** .

- **High-accuracy measurements from up to 48 thermocouples allowed precise characterization of temperature uniformity** within the curing ovens.

  By using the DT9871 TEMPpoint instrument, the customer was able to precisely measure 48 J-type thermocouples (24 inputs from each oven) embedded directly inside the composite material within the curing ovens.

  This provided valuable information about the curing process and the uniformity of conditions with the curing ovens.

- **TEMPpoint's robustness allowed continuous and reliable process monitoring** over the curing temperature range and curing cycle.

  Due to the design of the TEMPpoint instrument, the instrument reliably measured all 48 inputs continuously over the curing temperature range (up to 400 degrees F) and 4-hour curing cycle without failure.

- **The Instrument Pak version of Measure Foundry allowed rapid customization** of the ready-to-measure TEMPpoint application, allowing the customer to get up and running quickly, and to optimize the curing cycle.

  With minimal development time, the customer was able to customize the TEMPpoint application to generate a 3D map of temperature versus time. This data allowed the customer to characterize the curing process, minimizing the time required to bring the curing ovens up to the proper curing temperature without overshooting the curing temperature range.

  In addition, the application was customized so that operators could start and stop the application using a single mouse click, and engineers had access to key process set-up parameters.

  By monitoring the temperature of the curing ovens, the customer was able to optimize the curing cycle, thereby, reducing curing time and expenses.

  **Products Used**

  DT9871 USB TEMPpoint instrument

  Ready-to-Measure TEMPpoint application

  Measure Foundry Software, Instrument Pak version