MatchID
Metrology beyond colors

Application Note

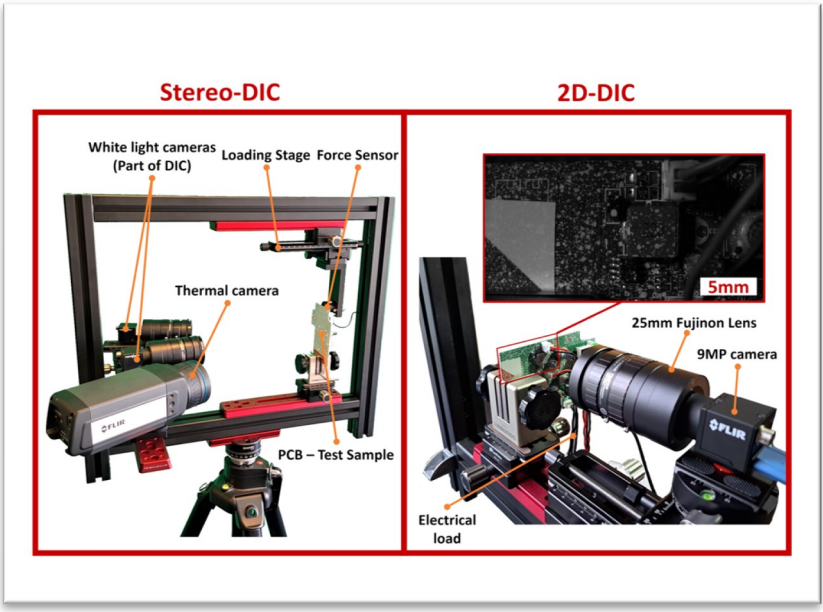
Study of thermal and mechanical deformations induced in an operational PCB

Case Description

Aim: Study full-field strains induced in a **PCB** due to a combined effect of mechanical and thermal loads. A force, primarily generating transverse bending, is applied to the PCB. The thermal strains originate from the temperature gradient generated during operation.

Approach:

- **Stereo-DIC system + infrared (IR) camera:** to measure strains and temperature gradients induced in operational PCB subject to transverse bending load.
- **Higher resolution 2D-DIC system + IR camera:** focus on the strain and temperature gradients solely due to thermal loads originating from the operational conditions of the PCB .



Experimental Setup

- ✓ **Stereo-DIC cameras:** 5 MPx Flir BFS-U3-51S5M-C
- ✓ **2D-DIC camera:** 9 MPx Flir BFS-U3-88S6M-C
- ✓ **Thermal camera:** 0.3 MPx Flir A615
- ✓ **Light Source:** Stroboscopic LED
- ✓ **Acquisition Speed:** 5 Hz
- ✓ **Field of View:** 40 cm X 40 cm

Analysis

- ✓ **Calibration:**
  - 100 calibration images, obtained with a heated calibration target, link the DIC and IR systems
- ✓ **Mapping procedure:**
  - Reprojecting temperature data in the frame of the DIC master camera allows to track simultaneously displacement and temperature evolution

Results*

- ✓ **Full field maps of the PCB under combined thermal and mechanical load:**
  - Temperatures
  - Contours of local strain concentrations around the PCB components
- ✓ **Time-evolution curves at two locations (PCB and resistor) under thermal load:**
  - Temperature
  - Normal bending strain

Why MatchID

- ✓ Support for IR cameras enabling temperature tracking to material points
- ✓ Full-field, information-rich strain maps obtained from 2D-DIC or stereo-DIC
- ✓ Advanced DIC algorithm leveraging high-order shape functions and interpolating techniques
- ✓ Fully integrated DIC uncertainty quantification tool

*Unless otherwise specified, all the dimensions and the relevant quantities are in mm.

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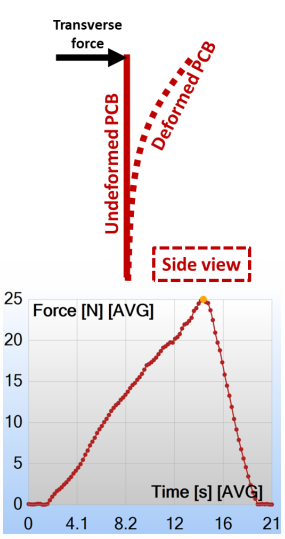
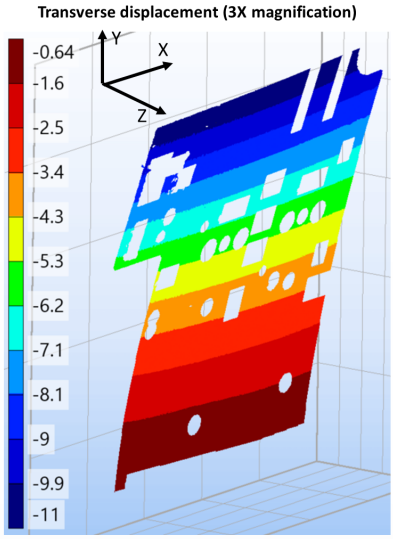
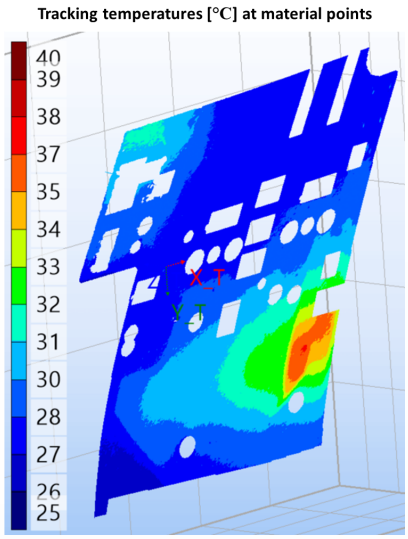
Thermal & mechanical load: Displacements and temperatures



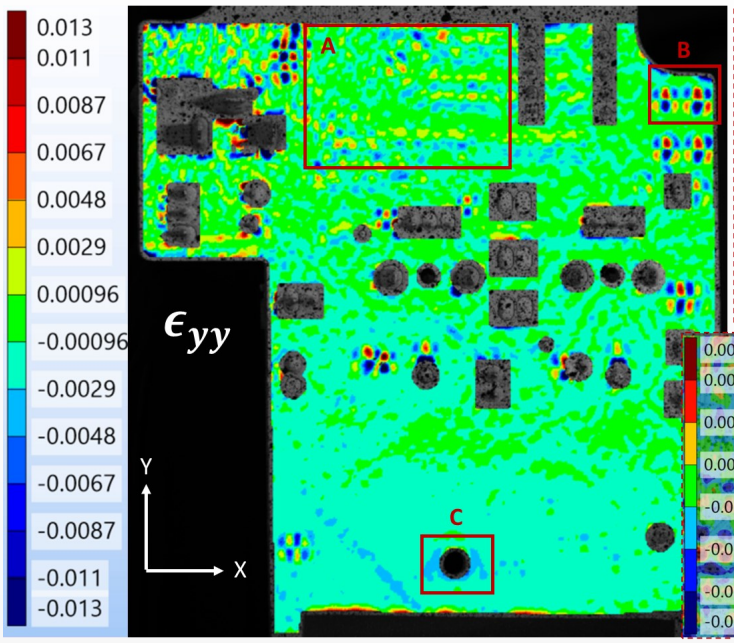


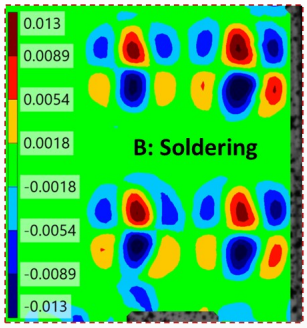


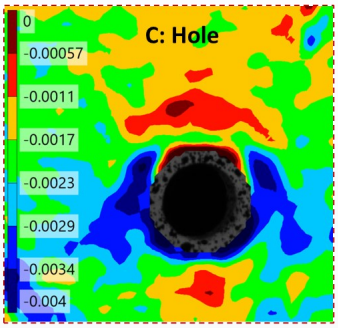
The transverse force, peaking at 25 N, introduces a transverse displacement in the PCB.

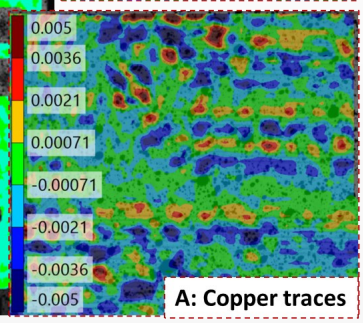
Temperatures at material points are tracked from the reference to the deformed state by importing the calibration information linking the DIC and IR-systems.

Thermal & mechanical load: strain maps





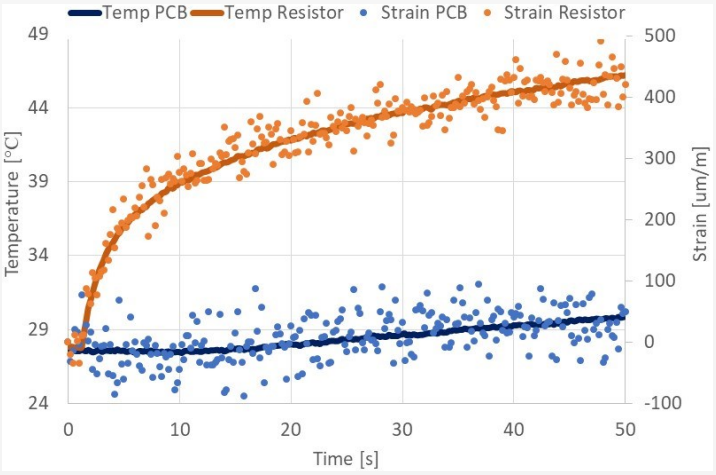


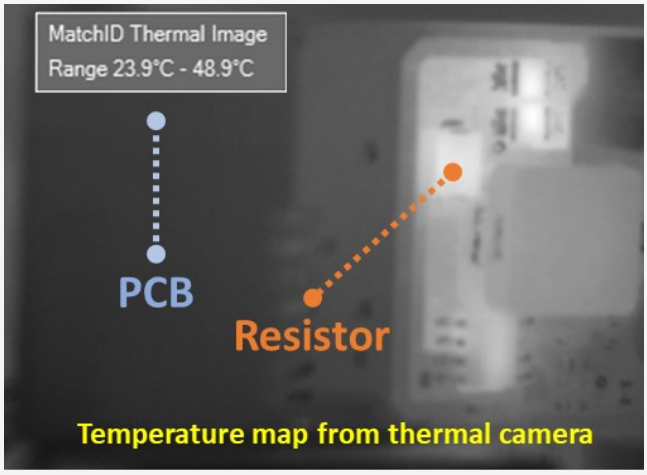


DIC can successfully detect local strain concentrations near the solder locations, holes and copper traces.

Our higher-order shape functions are crucial in obtaining converged strain data.

Thermal load: temperature and video extensometer strain





The **Resistor** heats up significantly more as compared to a **nominal location on the PCB**. The time-evolution of temperature and strain (measured with video-extensometer) correlate well with each other, demonstrating the potential of DIC to measure thermal strains in the PCBs. Increasing the camera resolution would allow using larger spatial filters yielding less noisy strains without compromising on the spatial resolution. MatchID's embedded uncertainty quantification capabilities help the user understand the trade-offs between the DIC processing parameters and the experimental considerations.