NT220 System Quick Start

Overview

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The NT220 is Microsanj's transient thermoreflectance imaging system (Visible & NIR Camera configuration), used to generate thermal images and temperature measurements of microelectronic devices under test. The system combines:

- A visible or NIR camera with LED illumination (530 nm LED for the Visible Camera; 1064 nm LED for the NIR Camera)
- A 20X objective lens / microscope
- A piezo-driven 3D motion and alignment stage ("4D Nano Align")
- Control software organized around a **Project Manager** that stores microscope and brightness settings for reuse across measurement modes

From the control software, the instrument supports three primary measurement workflows, plus a companion image-processing application:

- **Calibration** — establishes the sample's Thermoreflectance Coefficient (Cth) by cycling the sample through a temperature range (e.g., 20 °C to 120 °C) and measuring the reflectance response.
- **Transient Image** — captures pulsed/transient thermal images of a powered device (device pulse width and duty cycle controlled).
- **Steady State Image** — captures steady-state thermal images of a device held at a fixed ON/OFF voltage condition.
- **SanjAnalyzer PLUS** — a separate image-processing application used to open calibration and transient/steady-state image files, correct for thermal expansion, and measure ΔT (temperature difference) across a device.

This guide is based on the Microsanj-supplied test sample (see Microsanj Test Sample below) and walks through the standard system setup, calibration, imaging, and analysis sequence.

Quick Start Steps

Quick Start Steps

This is the common system setup sequence performed at the start of **every** measurement mode (Calibration, Transient Image, and Steady State Image) before proceeding to the mode-specific steps.

1. **Check System Status.** Make sure the System Status indicator is green for all items before proceeding. [diagram/image in source — not reproduced here]
2. **Set Illumination Control.**
    1. Set the Source to LED.
    2. Set the LED Wavelength to 530 nm for the Visible Camera (when using the NIR Camera, set LED Wavelength to 1064 nm).
    3. Click **Get Image** and spin or numerically adjust the LED Brightness control until you get a clear, focused image of the micro heater.
3. **Set up the Microscope & Camera.**
    1. Make sure the 20X Objective is on the microscope and select 20X Magnification.
    2. Set Frame Rate to 35.
4. **Set Motion Control.** (Note: make sure the stage is clear beforehand.)
    1. Click **Center Stage**.
    2. Click the **Enable 3D Motion** checkbox to apply voltage to the Piezo Stage, then click **OK** on the pop-up window.
5. **Select the Operation.** Choose the desired operation from the Operations Selection controls — click **Calibration**, **Transient Image**, or **Steady State** to start that workflow (see the mode-specific sections below). [diagram/image in source — not reproduced here]

Microsanj Test Sample

Microsanj Test Sample

Sample Structure

The Microsanj test sample layer stack (from the source diagram): a SiO2 (200 nm) top layer; Au(130 nm)/Cr(5 nm) contact pads on either side; a SiO2 (300 nm) layer; a Si (n++) substrate core; and a SiO2 (300 nm) bottom layer. [diagram/image in source — not reproduced here]

Sample Layout and Equipment

Set Up Equipment:

- NT220 Transient Thermoreflectance System
- 530 nm LED & 1064 nm LED
- 20X Objective Lens

Device Layout:

- **Device 1:** 2 µm Au Point — Pins 1 & 2
- **Device 2:** 5 µm x 500 µm Au line — Pins 12 & 15

[diagram/image in source — not reproduced here, showing physical pin layout for Device 1 and Device 2]

Project Manager

The Project Manager screen shows the Project Manager Controls alongside the current image of the sample. [diagram/image in source — not reproduced here]

Calibration

Calibration

Perform the common setup in Quick Start Steps, then click **Calibration** to start. Continue with the steps below.

1. **Hardware**
    1. Set Base Temp to 20 °C and click **Set Low Temp**.
        - Note: The temperature set on the 4D Nano Align should change. If it does not, make sure the Chiller is on.
    2. Set High Temp to 120 °C.
        - Note: Microscope Settings are auto-filled from Project Manager (no need to reselect them).
2. **Timing/Illumination**
    1. Set Stage Heating Time to 50.
    2. Set Image Averages to 55.
    3. Auto-select the Brightness (%).
        - Note: Brightness % is auto-filled from Project Manager (no need to reselect it).
3. **3D Alignment – Focus ROI**
    1. Select a region on the CCD image using the rectangle tool. Choose a unique feature on the sample, such as edges or scratch marks.
    2. Press **Focus ROI** to set the selected region as your ROI.
    3. Wait a few seconds until the selected region is focused as your ROI and the Focus ROI indicator turns green.
        - Note: The selected ROI region displays in green. To zoom in/out, use the magnifying glass — hold Shift to zoom out, Shift+Click to zoom in.
4. **3D Alignment – Capture Ref**
    1. After selecting the ROI, keep the same ROI or select another region with more distinct features for alignment.
    2. Press **Capture Ref** to set the newly selected region as the Reference region.
    3. Wait for the Capture Ref indicator to turn green.
    4. Set the initial parameters for Focus Tolerance, Alignment %, and Vibration Filter. The indicator lights turn green when the image is in range.
        - Note: Increasing the Alignment % value and decreasing the Vibration Filter improves alignment accuracy.
5. **Start Measurement**
    1. Once setup is complete, click **START Measurement** to begin calibration.
6. **Save Images**

1. The calibration cycles through temperatures to reduce noise and improve accuracy. Typically after 3 cycles, the thermoreflectance error is <1E-5 (or <5% for 530 nm on gold material). The System Status bar shows progress and displays "Calibration Done" after each cycle, and counts cycles under "Loop Iterations".
    - Note: Each cycle takes about 4 minutes.
2. Select a region on the Thermal Image View to get the Thermoreflectance Coefficient (Cth) while the measurement is running. (Example in source: the middle of the blue 5 µm x 500 µm band is selected.)
3. Under Save Images, check that the directory and "Save Path" name are correct.
4. Check the **Save Every Cycle** box. When ready to save the data, click **Save Image**.
    - Note: Save the image before stopping the measurement.
5. To stop the measurement, click **STOP MEASUREMENT**, or click **File > Quit**.

Transient Image

Transient Image

Perform the common setup in Quick Start Steps, then click **Transient Image** to start. Continue with the steps below.

1. **Hardware**
    1. Set the Base Temp to 20 °C, then click **Set Base Temp**.
        - Note: Microscope Settings are auto-filled from Project Manager (no need to reselect them).
2. **Timing/Illumination**
    1. Set Device Pulse Width(s) to 100 µs.
    2. Set Duty Cycle to 10%.
    3. Auto-select the Brightness (%).
        - Note: Make sure the "Brightness Good" indicator is green. Increasing the duty cycle increases the overall illumination and the total power delivered to the device, which may lead to device overheating.
3. **3D Alignment – Load Ref**
    1. Click **Load Ref** to load the file from Calibration, or Focus and Capture a new image.
    2. Wait a few seconds until the selected region is focused and the Load Ref indicator turns green.
    3. Set the parameters for 3D Nano Alignment and Digital Anti-Vibration.
    4. Set the initial parameters for Focus Tolerance, Alignment %, and Vibration Filter. The indicator lights turn green when the image is in range.
        - Note: Increasing the Alignment % value and decreasing the Vibration Filter improves alignment accuracy.
4. **Device Control**
    1. The Device Trigger OUT outputs 5 V into 50 Ohms. If the device has high impedance, Device Trigger applies 10 V.
    2. Update Voltage is automatically on.
    3. The software sets Image Delay(s) to 100 µs.
    4. Press **Start Measurement**.
5. **Save Thermal Image**
    1. After sufficient averaging time, the hot line should appear (a few seconds).
    2. Change the Pallet from Temperature to Rainbow display.
    3. Select a region on Thermal Image View to get the Region Temperature while the measurement is running. (Example in source: the middle of the green 5 µm x 500 µm band is selected.)

4. Enter the estimated Thermoreflectance Coefficient (Cth) from the calibration to get a more accurate ROI Temperature.
5. Under Save Images, check that the directory and "File Path" name are correct.
6. When ready to save the data, press **Save Image**.
    - Note: Save the image before stopping the measurement.
7. To stop the measurement, click **STOP MEASUREMENT**, or click **File > Quit**.

Steady State Image

Steady State Image

Perform the common setup in Quick Start Steps, then click **Steady State** to start. Continue with the steps below.

1. **Hardware**
   1. Set the Base Temp to 20 °C.
   2. Set Device ON Voltage to 5 V and Device OFF Voltage to 0 V.
      - Note: Microscope Settings are auto-filled from Project Manager (no need to reselect them).
2. **Timing/Illumination**
   1. Set Device On Time to 10.
   2. Set Image Averages to 50.
   3. Set the Duty Cycle to 50%.
   4. Auto-select the Brightness (%).
3. **3D Alignment – Load Ref**
   1. Click **Load Ref**.
   2. Select the saved file from Calibration.
   3. Wait a few seconds until the selected region is focused and the Load Ref indicator turns green.
   4. Set the initial parameters for Focus Tolerance, Alignment %, and Vibration Filter. The indicator lights turn green when the image is in range.
      - Note: Increasing the Alignment % value and decreasing the Vibration Filter improves alignment accuracy.
4. **Start Measurement**
   1. Once setup is complete, click **START Measurement** to begin the measurement.
      - Note: the source document literally reads "to begin calibration" here; this appears to be a copy/paste artifact carried over from the Calibration section rather than a distinct step — flagged here for anyone updating this procedure against the vendor source.
5. **Save Images**
   1. After sufficient averaging time, the hot line should appear (a few seconds).
   2. Select a region on Thermal Image View to get the ROI Temperature Value. (Example in source: the middle of the green 5 µm x 500 µm band is selected.)
   3. Enter the estimated Thermoreflectance Coefficient (Cth) from the calibration to get a more accurate ROI Temperature.

4. Under Save Images, check that the directory and "Save Path" name are correct.
5. When ready to save the data, press **Save Image**.
    - Note: Save the image before stopping the measurement.
6. To stop the measurement, click **STOP MEASUREMENT**, or click **File > Quit**.

> Note on source step numbering: the vendor source labels both "Click START Measurement" and "Save Images" as step "4" in this section. They are presented here as steps 4 and 5, in the order they appear in the source, for clarity.

SanjAnalyzer PLUS – Image Processing

SanjAnalyzer PLUS – Image Processing

SanjAnalyzer PLUS is the companion application used to open and process saved calibration, transient, and steady-state image files. Its main view includes a File Window, a Working Image pane, a Reference Image pane, and an Image Calibration Window. [diagram/image in source — not reproduced here]

1. **Open Calibration Image**
   1. Open the file location where all test images are saved.
   2. Open the Calibration Image file.
   3. Check **Correct XY** to correct for thermal expansion.
2. **Save Calibration Image**
   1. Click **Save Images/Data**.
   2. Change Image Save Format to TTI.
   3. Click **Save Image (Current VIEW)** to capture the image.
   4. If TTI is already selected, click **Quicksave** instead.
3. **Open Transient Image**
   1. Click **Open File**.
   2. Select **Refresh** to update the file list with the corrected Calibration Image.
   3. Open the Transient Image file (double-click).
   4. Select **Point by Point** — the Load Cth Map dialog will pop up.
   5. Select the corrected Calibration Image file from the browse dialog and click **LOAD**.
4. **Measuring ΔT**
   1. Using the rectangle tool, drag the ROI box across the length of the specimen to measure temperatures in that range. You can draw up to 5 ROI boxes to measure and compare temperatures at different locations on the specimen.
   2. Select **Thermal Cross-Section**.
   3. Click **Rectangular Profile** to see the rectangular profile of the temperatures within the ROI box.
      - Note on the ROI boxes shown in the source example image: a green ROI box measures ΔT along the length of the specimen line; a yellow ROI box measures

peak temperature.

5. **Measuring ΔT – Alignment Accuracy**
    1. If an accurate ΔT is desired on smaller features, increase the Alignment % used during the calibration process. This increases the time required for the measurement but provides better results. [diagram/image in source — not reproduced here — shows a more accurate result obtained with a higher Alignment %]
    2. Be aware that a less accurate measurement can result from a misaligned or moved device: the source example shows red lines appearing as a result of the device not being properly aligned and/or movement of the device. [diagram/image in source — not reproduced here]

Notes and Cautions

Notes and Cautions

Notes and cautions called out throughout the source procedures, consolidated here for reference:

- **Stage clearance:** Before using Motion Control (Center Stage / Enable 3D Motion), make sure the stage is clear.
- **Chiller check:** During Calibration hardware setup, if the temperature on the 4D Nano Align does not change after setting Base/Low Temp, verify the Chiller is on.
- **Auto-filled settings:** Microscope Settings and Brightness % are auto-filled from the Project Manager in Calibration, Transient Image, and Steady State Image modes — they do not need to be reselected.
- **Save before stopping:** In Calibration, Transient Image, and Steady State Image modes, always save the image *before* clicking STOP MEASUREMENT.
- **Device overheating risk:** In Transient Image mode, increasing the Duty Cycle increases the overall illumination and total power delivered to the device, which may lead to device overheating.
- **Alignment accuracy trade-off:** Increasing Alignment % and decreasing the Vibration Filter improves alignment accuracy (Calibration, Transient Image, Steady State Image) but increases measurement time (also noted for SanjAnalyzer PLUS ΔT measurements on small features).
- **Device Trigger OUT (Transient Image):** Outputs 5 V into 50 Ohms; if the device under test has high impedance, Device Trigger applies 10 V instead.

Source Documents

Source Documents

- *Quick Start Guide for NT220 System – Visible & NIR Camera – Microsanj Test Sample*, Microsanj, LLC, Copyright 2021 (source PDF, text-extracted). Microsanj, LLC, 48421 Milmont Drive, Fremont, CA 94538; info@microsanj.com.