Nano Therm System

Overview

Overview

The Nano-THERM Series (platform NT220, with the NTIR220 infrared variant and the VT200 vibration-isolation/dark-box option) is Microsanj's non-contact temperature measurement system for active semiconductor devices. It is a benchtop precision analysis tool for static and transient thermal imaging on a millimeter-to-micron scale. The system is built around the EZ-THERM ("General Purpose Thermal Analyzer") controller platform, also referred to in places in the source manual as EZ500A.

What it measures. The system measures temperature non-contact using two physical techniques:

- **Thermoreflectance (TR) imaging** — a highly sensitive lock-in technique that measures the relative change in a sample surface's reflectivity as a function of temperature, per pixel. The relationship is approximated to first order as:
  $\Delta R(x,y,\lambda) / R(x,y,\lambda) = Cth(x,y,\lambda) \cdot \Delta T$
  where Cth (the thermoreflectance calibration coefficient, also called C^{tr}) is typically on the order of 10^{-3} to 10^{-5} per °K and depends on sample material, illumination wavelength, angle of incidence/surface roughness, and sample composition. The technique is sensitive to shifts and thermal expansion at length scales of 580 nm at 20x magnification.
- **Infrared (IR) emission imaging** — using a longwave infrared (LWIR) camera, requiring an emissivity (E) coefficient for accurate temperature readings (emissivity must be recalibrated per sample, unlike the thermoreflectance coefficient, which is largely material-dependent and does not require per-device calibration).

Hardware family / major components. Any system shipped to a customer consists of:

1. Optical Microscope
2. Camera (Visible, Infrared, Near-IR, and/or InGaAs, depending on configuration)
3. Standard Rack Models (electronics rack housing the control modules)
4. Probe Station (option)

Rack-level modules include SanjSCOPE (power control), SanjSOURCE (illumination), SanjCONTROLLER+ (integrated desktop computer running SanjVIEW), 4D Nano Align (thermal stage + piezo controller housing), the Piezo Controller for AF-100, and the 600W rack-mount chiller. See "Setup and Installation" for a description of each module.

Software. All hardware is operated through **SanjVIEW 7.0**, embedded on the SanjCONTROLLER+. SanjVIEW's modules are: Project Manager, Transient Thermoreflectance, Movie Mode, FA (Failure Analysis) Mode, Calibration, SanjANALYZER (post-acquisition analysis), and an Output Module for device biasing signals.

Safety Precautions

- **WARNING — high temperature:** do not touch the thermal plate when it is in operation; contact can cause severe burns.
- **WARNING:** there are no user-serviceable parts inside the EZ-THERM controller. Do not remove covers. Exposed AC power can be present even with the power switch off. To avoid accidental shock, turn off the power and unplug the line cord before checking or replacing the fuse. Only use the specified fuse value; do not attempt to bypass or repair the fuse.
- **WARNING — shock hazard:** use extreme care when handling output connections.
- **WARNING — UV radiation exposure:** there are no regulatory UV exposure limits. The ACGIH (American Conference of Governmental Industrial Hygienists) publishes Threshold Limit Values (TLVs), wavelength-dependent, ranging from 3 mJ/cm² to 100,000 mJ/cm²:
  - UV-A (315–400 nm): 1.0 J/cm² for exposures under 1000 seconds; 1.0 mW/cm² for exposures over 1000 seconds.
  - UV-B: 3.4 mJ/cm² at 280 nm; 500 mJ/cm² at 313 nm.
  - UV-C: 250 mJ/cm² at 180 nm; 3.1 mJ/cm² at 275 nm.

Personal Protective Equipment (PPE)

If engineering/administrative controls cannot protect personnel from UV exposure, use PPE: UV safety goggles, UV face shields, long-sleeved tightly woven clothing covering most of the body, and gloves. Sunscreen with SPF > 15 against UV-A/UV-B may provide some protection, but UV skin blocks alone are considered inadequate against high-irradiance man-made UV sources. For eye protection, polycarbonate safety glasses or a polycarbonate face shield are generally sufficient; wear this eyewear whenever there is potential for ongoing UV exposure. Contact EH&S for guidance on appropriate UV protective eyewear. Any equipment emitting UV radiation, and its work area, must have appropriate UV warning labels posted (there is no standard label format).

Specifications

Specifications

Facility Requirements

Item	Value
Typical workspace	8 ft wide × 6 ft deep
Wall clearance	>12 in, needed for rack cooling air flow
NT220 weight	~260 lbs (~120 kg)
VT200 weight	~507 lbs (~230 kg)
Internet connection	Recommended for remote data access/tool control; not required for operation
Compressed Dry Air (CDA)	>50 psi required for the vibration isolation table (portable compressor acceptable if no facility line)
Vacuum	Required to hold the wafer (portable vacuum pump acceptable if no facility supply)
Power	~2500 W, 120V/240V – 20A

Other recommendations: install away from large mechanical equipment/motors (vibration can degrade specifications); install in as clean an environment as possible to prevent dust/particle contamination of measurements.

NT220 Platform Specification

Parameter	Base	PKG-1	PKG-2
Transient Response	50 ns LED pulse duration (FWHM), 12.5 ns delay resolution	(same)	(same)

Parameter	Base	PKG-1	PKG-2
Operating System	SanjCONTROLLER™ with embedded SanjVIEW (system management, acquisition, processing, analysis)		
Selectable SanjSOURCE™ models	NT220-40: LS310-40 — 365, 470, 530, 780 nm	NT220-80: LS310-80 — 365, 405, 455, 470, 530, 625, 656, 780 nm	NT220-44: LS310-44 — 365, 470, 530, 780, 985, 1064, 1210, 1370 nm
Display	30-inch 4K monitor, keyboard & mouse		
Operating temperature	10 °C to 35 °C	10 °C to 35 °C	10 °C to 35 °C
Power	120V/240V, ~1500 W	120V/240V, ~2000 W	120V/240V, ~2500 W
Rack size (D×W×H)	36" × 24" × 29"	36" × 24" × 46"	36" × 24" × 46"
Electronics rack weight	190 lbs (~90 kg)	210 lbs (~95 kg)	260 lbs (~120 kg)

CTR Piezo Calibration (available as an after-purchase option):

Parameter	AF-100	AFP-200
Temperature range	20 °C to 120 °C ±1% Typ	20 °C to 150 °C ±1% Typ
Leveling adjustment	±5 degrees	±2 degrees
Heating/cooling capacity	50 W	500 W
Stage working area	40 mm × 40 mm	125 mm × 125 mm

Probe Station (available as an after-purchase option):

Parameter	SPS-400	GPS-150
Chuck	4" vacuum chuck	6" vacuum chuck
X-Y travel	100 mm × 100 mm	150 mm × 150 mm
Probes	3 DC probes	3 DC probes

Optical Microscope / Fiber Illumination (LLGVIS8 / LLGNIR8)

Parameter	LLGVIS8	LLGNIR8
Wavelength range	340 nm to 800 nm	420 nm to 2000 nm

Parameter	LLGVIS8	LLGNIR8
Numerical aperture	0.59	0.59
Half angle	36°	36°
Minimum bend radius	60 mm	60 mm
Core diameter	5 mm	5 mm
Length	8 ft (2.4 m)	8 ft (2.4 m)
Temperature range (continuous)	-5 to 35 °C (23 to 95 °F)	-5 to 35 °C (23 to 95 °F)

`[diagram/image in source — not reproduced here: Figures 1, 2, 4, 5, 6 — microscope frame, C-mount fiber illumination, microscope dimensions/views, camera]`

Cameras

- **Visible camera**: 2 megapixel or 4 megapixel; mounted atop the microscope to capture images from the lens.
- **Infrared (LWIR) camera**: compact longwave infrared thermal camera using FLIR infrared video processing architecture; low power consumption. 12 µm pitch Vanadium Oxide (VOx) uncooled detector, 640 × 512 resolution. Available with 2.5x lens or 0.1–0.5x adjustable lens.
- **InGaAs camera**: InGaAs sensor for extended infrared spectral sensitivity, 900–1700 nm, with high sensitivity and high frame rates at full resolution (higher still with a smaller ROI selected).
- **Visible/NIR camera comparison** (Section 10): a visible (monochrome or color) camera captures 400–780 nm to produce human-vision-like high resolution images; a NIR camera captures 780–1400 nm, invisible to the human eye, useful beyond visible light and in low-light conditions.

SanjSOURCE (illumination module)

Nanosecond multi-wavelength light source, auto-selectable, up to eight LED wavelengths: 365, 405, 455, 470, 530, 625, 656, and 780 nm (visible), plus 970, 1050, 1300 nm (near-infrared). Other wavelengths available on request.

Rear-panel connectors:

Connector	Function
A. LED Output	Bias external LEDs — 2.5 A peak pulsed current, 1 A DC

Connector	Function
B. LED Trigger IN	Trigger the light source externally
C. LED Trigger OUT	For external light sources
D. Device Trigger IN (option)	Externally trigger the NT220 system
E. Device Trigger OUT	Trigger external power supplies — 5V into a 50 Ω load. Note: outputs 10V into high impedance and sources 200 mA max into a short circuit

4D Nano Align / Piezo Controller (AF-100)

4D Nano Align houses the power source for the thermal stage's thermo-electric element and the piezo controller. The ATEC302 temperature controller monitors and sets stage temperature manually. Depending on configuration, 4D Nano supports Auto Focus 100 (AF-100) or Auto Focus 200 (AF-200).

Piezo Controller for AF-100: voltage amplifier with closed-loop control and a PC-interfaced display showing actuator position, operating mode, and internal amplifier temperature. AF-100 provides 3-axis XYZ positioning, 100 × 100 × 100 µm travel range, ±5° tip-tilt adjustment. Applications include drift-compensated control of piezo actuators with resistive measurement systems, lab, and industrial use.

600 W Rack Mount Chiller

19" wide, 3U-height, compressor-refrigerant recirculating liquid chiller rated at 600 W (2047 BTU/hr at 25 °C liquid & ambient).

Parameter	Value
Operational temperature range	0–40 °C (ambient and liquid)
Pump	10 manual levels: 3.5 LPM (level 1) to 6.5 LPM (level 10)
Liquid coolant	Koolance 702 (required — see Maintenance)
Power source	100–240 VAC, 50–60 Hz
Maximum operating temperature	40 °C
Minimum operating temperature	-20 °C

ATEC302 Temperature Controller

Bi-directional temperature controller/indicator for thermoelectric applications.

- 4 temperature zone control modes: P, PI, PD, PID, Auto Tuning, Open-Loop Control
- High-speed ADC; wide-range T/C, RTD, Thermistor input, selectable
- DC power supply: 9–36V or 5V DC
- 2 programmable alarm outputs
- RS232, RS485, and USB communication with GUI software
- Supports complex program scripts for sophisticated temperature profile control

Optical Heads (Single TR Mount)

Note: the source PDF's table extraction interleaved these columns; values below are reconstructed by matching row-position across the four model columns and should be spot-checked against the original PDF figure before external use.

	SMC40-VIS2PK	SMC40-VIS4PK	SMC40-NIRIPK	SMC40-NIREPK
Sensor	2MP CMOS	4MP CMOS	630 × 508 pixels InGaAs	1MP EMCCD
Wavelength range	400 nm to 800 nm	365 nm to 1050 nm	900 nm to 1700 nm	480 nm to 1060 nm
Resolution @100x	59 nm/pixel	55 nm/pixel	150 nm/pixel	130 nm/pixel
Field of View	2.3 × 1.4 mm @5x	2.3 × 2.3 mm @5x	3.8 × 3.0 mm @2.5x	5.3 × 5.3 mm @2.5x
NETD	100 mK	250 mK	— (not stated)	— (not stated)

Included VIS band objectives: 5x (5SVIS35), 20x (20SVIS22), 100x (100SVIS14). Included NIR band objectives: 2.5x (2.55NIR12), 20x (20SNIR12).

Dual TR mount optical heads:

- SMC40-V4NIPK: SMC40-VIS4PK plus SMC40-NIRIPK, plus VIS and NIR band objectives
- SMC40-V4NEPK: SMC40-VIS4PK plus SMC40-NIREPK, plus VIS and NIR band objectives

Additional Accessories and Options

Item	Spec

EZIR-LW12PK / EZIR-LW12SPK (infrared sensor)	Uncooled VOx LWIR sensor, 640 × 512 pixels, 30 fps, 7.5–13.5 µm spectral range, 10 mK NETD. EZIR-LW12SPK frame rate is 8.6 fps.
L05LWIR	0.5x lens; resolution 24 µm/pixel; FoV 15.4 × 12.3 mm
L25LWIR	2.5x lens; resolution 4.8 µm/pixel; FoV 3.1 × 2.5 mm
SA-200 SanjANALYZER-PLUS™	Advanced post-data processing & analysis
Optional Objectives	NUV, VIS, or NIR bands, 1x to 100x, varied Numerical Apertures (NA) and Working Distances (WD)
Optional Illumination Sources	Wavelengths other than those in LS310-40/-80/-44; inquire with Microsanj
VT100 Vibration Table	30" × 36" (750 × 900 mm) area vibration isolation table
VT200 Vibration Table	30" × 36" (750 × 900 mm) area vibration isolation table with dark box enclosure

Output Module Signal Reference

Signal	I/O	Function
VI EXT (A) — DC voltage in	Input	Used in "Relay" mode for pulsing device. ±60V, 3A maximum
VO EXT (B) — DC voltage in	Output	Modulated output of VI DC input voltage
AUX INT (C) — Aux out	Output	±10V, 500 mA max (not pulsed)
VO INT (D) — Voltage out	Output	Main output, ±10V, 1A maximum. Output when used in "Relay" mode: ±60V, 3A max
VO INT (D), 20 mA Range	Output	500 Ω output impedance, approximately 2 mA/V into low impedance
TRIG (E) — Trigger out (Movie mode only)	Output	Synchronizes external equipment with Movie mode. TTL high-impedance output

Device Biasing / Trigger Connectors (SanjCONTROLLER

PLUS™)

Connector	Function
A. VI EXT	Input for fixed DC voltage up to +60V
B. VO EXT	Pulsed output of DC voltage input to VI EXT
C. AUX INT	Up to ±10V DC for secondary DUT bias
D. VO INT	Up to ±10V pulse for DUT pulsed bias
E. TRIG	Internal mode output — 5V TTL pulse to sync external DUT bias supply

`[diagram/image in source — not reproduced here: Section 9.2–9.8 timing/biasing diagrams — "Relation to Timing Sequence for Transient Analysis," "Internal Biasing," "External DC Supply," "Triggering an External Source," "Slave Mode," "Transient Timing Signal," "Transient Software with Light Emission"]`

Camera / LED Compatibility (NIR mode)

Camera Selection (F1)	Select LED (F3)
VISIBLE	405, 470, 530, 780 nm
NIR	1050, 1100, 1200, 1300 nm

Setup and Installation

Setup and Installation

1. System Description (components)

Any Nano-THERM system consists of: Optical Microscope, Camera, Standard Rack Model(s), and (optionally) a Probe Station. The rack front panel is shown in the source as Figure 7 `[diagram/image in source — not reproduced here]`, and includes:

- **SanjSCOPE** — the power control module, with Emergency Off, chiller power switch, and master power switch (Figure 8, not reproduced).
- **SanjSOURCE** — the illumination module (see Specifications above).
- **SanjCONTROLLER+** — an integrated desktop computer connecting all modules and hardware, supporting both Thermoreflectance (TR) and Infrared (IR) functions, all managed via SanjVIEW 7.0.
- **4D Nano Align** and **Piezo Controller for AF-100** — thermal stage TE power source and piezo controller housing (see Specifications above).
- **600W Rack Mount Chiller** — recirculating liquid chiller for the thermal stage (see Specifications and Maintenance).
- **ATEC302 Temperature Controller** — bi-directional stage temperature control (see Specifications above).

2. Connecting the Nano-THERM System

Before making any connections, ensure all modules are powered off. Complete all connections and power on modules before running SanjVIEW v6 or v7.

Components needed for a Nano-THERM system:

1. Visible camera and USB 3.0 cables (camera to SanjCONTROLLER; camera trigger to SanjSOURCE)
2. Microscope with lenses
3. Thermocouple TC-01 (connects to SanjCONTROLLER)
4. Thermal Electric cable (connects thermal stage to 4D-Nano)
5. National Instruments PCIe 6612 Counter/Timer I/O cable (between SanjCONTROLLER and SanjSOURCE)
6. IR cable (IR camera to SanjCONTROLLER+)
7. HDMI cable (monitor to SanjCONTROLLER)
8. Piezo cable (Piezo stage to Piezo Controller in 4D-Nano)
9. Liquid lightguide for visible or near-infrared LED (microscope to SanjSOURCE)
10. Test sample
11. Ethernet cable (optional, for SanjCONTROLLER network connection)

`[diagram/image in source — not reproduced here: Section 4.7–4.10 rear-panel connector diagrams for AF200, SanjSOURCE, SanjCONTROLLER+, and 4D-Nano]`

4D-Nano rear panel connectors (for AF-100):

1. Temp controller USB
2. Thermal couple
3. Thermal Electric (TE) cable
4. Piezo USB cable
5. XYZ Piezo
6. Power — connects to Chiller DPU
7. Power — connects to Master DPU

Power Distribution Units (DPUs):

- **Master DPU** — powers the monitor, SanjSOURCE, SanjCONTROLLER, and the 4D Nano.
- **Chiller DPU** — powers the chiller and the 4D Nano.

Power-up procedure (confirm the Main Power Strip is connected to the proper outlet — 110V or 220V — first):

1. Ensure the Red Emergency Off (EMO) button is released (turn counterclockwise).
2. Flip the Master and Chiller switches to the ON position.
3. Press the 4D-Nano power button.
4. Press the SanjSOURCE power button.
5. Press the SanjCONTROLLER power button.
6. Press the Chiller power button.

Notes:

- This power-up sequence covers the SanjSCOPE, the two DPUs, and the optional battery backup power supply.

- A **Battery Backup Power Supply** is available as an option to protect sensitive equipment during power surges and allow the user to save data.
- Chiller (internal or external) cooling fluid hoses connect to the 4-inch or 6-inch thermal stage of the system.

3. TEA Test Sample Setup

The Microsanj TEA test kit includes: a Microsanj-TEA test sample, (3×) 2 mm screws, non-conductive thermal paste, and a bias cable connector with a BNC connector (pre-wired to series resistors [D1] and a diode [D2] in the test sample). `[diagram/image in source — not reproduced here: Figure 2, TEA sample layout photo]`

Procedure — prepare hardware and connections:

1. Apply a small amount of thermal paste evenly to the center of the thermal stage (or the metal backside area of the sample) for good heat transfer.
2. Secure the Microsanj-TEA test sample to the thermal stage using screws or clamps.
3. Plug the BNC cable into the VO INT output.
4. Plug the connector from the BNC cable into the test sample.
5. Plug the thermal sense lead (attached to the test sample) into the thermal reader.

Maintenance

Maintenance

Chiller Coolant — Filling and Power-On

Once all devices (cold plates, fittings, etc.) are connected with tubing, fill the system with coolant:

1. With the fill port oriented upright, remove the large reservoir cap (fill port is located above the reservoir).
2. Never completely fill or "top off" the reservoir — an air gap must always remain to accommodate thermal expansion of the liquid.
3. Use the maximum/minimum fill markings on the front of the unit to gauge coolant level.
4. Slowly fill the system with coolant. Use only Koolance-approved coolant to maintain the product warranty — alternative liquids/additives can cause permanent damage (chemical reaction, corrosion, biological growth, high thermal expansion, viscosity issues, etc.).
5. Replace the fill port cap on the reservoir.

Chiller Coolant — Refilling

A secondary fill port is located on the front of the unit for convenience:

1. Open the air-release port.
2. Insert the funnel into the tubing and attach the fitting.
3. Connect the tubing to the secondary fill port.

Chiller Coolant — Draining

A drain is located on the front of the unit for emptying or replacing coolant:

1. Open the air-release port.
2. Attach the included fitting to the tubing.
3. Connect the tubing to the drain.

Controller Service Notice

There are no user-serviceable parts inside the EZ-THERM controller. Do not remove covers — exposed AC power can be present even with the power switch off. To avoid accidental shock, turn off the power and unplug the line cord before checking or replacing the fuse. Use only the specified fuse value; do not attempt to bypass or repair the fuse.

Appendix: Thermoreflectance Imaging Fundamentals

Appendix: Thermoreflectance Imaging Fundamentals

(Preserved from the source manual's Appendix A for internal engineering/support reference.)

Thermoreflectance thermal imaging relies on the linear change of a material's reflection coefficient with temperature. The effect was first noted in the 1960s; practical thermoreflectance imaging techniques are more recent. Because the reflection changes are imperceptible to the human eye, high-resolution, low-noise equipment and sophisticated averaging schemes are required. The NT220 provides two averaging modes:

- **Low Frequency Imaging** — a frequency-domain filtering technique. Advantages: works without pulsed illumination, and enables lower-frequency thermal images (down to 0.48 Hz) in "Transient" mode. It is possible to obtain low-frequency images without the BNC 6040/202H LED pulse generator, using CW (non-pulsed) illumination — useful for materials needing specific non-LED wavelengths (e.g., white light + bandpass filter). Disable the pulse generator (uncheck "use BNC 6040/202H" in Project Manager) when using CW illumination, to avoid unnecessary wear on the BNC and pulsed LED.
- **Transient Thermoreflectance Imaging** — captures thermal images at precise "snapshots" in the device's heating/cooling cycle via precise timing of illumination flash vs. device excitation. Has a lower noise floor (0.2 °C) than low-frequency imaging (0.5 °C), and is preferred when possible. A transient image series lets you visualize temperature change during the active heating cycle; the analyzer tools can display temperature at a given point across different times.

Thermoreflectance Material Coefficient

The thermoreflectance coefficient is a material property, a function of temperature and illumination wavelength. Unlike infrared emissivity, it is not strongly sensitive to surface preparation or deposition method, so per-device calibration is generally not necessary — Microsanj's characterization of gold prepared by various thermal/E-beam evaporation techniques has been consistent over years. A significant change in visual material color from major microstructure/porosity changes can, however, meaningfully change the coefficient.

Microsanj provides thermoreflectance coefficients for basic IC materials at the LED colors supplied with the system. For a new material system, the coefficient can be extracted directly if there is an embedded temperature sensor near the ROI on the chip; otherwise a small chip sample (roughly 1×1 mm up to 1×1 cm) can be sent to Microsanj for in-house characterization.

For regions of interest covered in Aluminum, use the provided 780 nm LED — the thermoreflectance coefficient is too small at 530 nm (green) and 470 nm (blue) to produce usable thermal images.

Dielectric coatings: coatings change the surface reflectance coefficient and thus the thermoreflectance coefficient. If uncoated regions are present, use temperature continuity across the surface to calibrate the image; otherwise Microsanj can determine the coefficient for a coated sample given a small piece. Non-uniform dielectric film thickness can produce interference oscillations in reflected data (an inherent optical property); averaging measurements across different color LEDs can help detect the oscillation envelope and remove the optical artifact.

Microscope objective numerical aperture: the thermoreflectance coefficient can depend on the objective's numerical aperture (NA), due to the surface-perpendicular polarization component — non-negligible for NA > 0.5. Coefficients Microsanj provides specify the objective and illumination LED used. For precise high-NA temperature measurements, first measure with a low-NA lens over a larger area, then (without changing anything else on the device) switch lenses and scale the temperature data accordingly. Standard objectives are optimized for the visible (VIS) band but usable outside that range with reduced sensitivity; Microsanj offers NUV/NIR-optimized objectives (see the Optional Objectives tables referenced in Specifications — detailed NA/FOV/working-distance/resolution tables are figures in the source PDF and not reproduced here).

Measurements at different ambient temperatures: thermoreflectance's key advantage over IR emission is that it works over a wide temperature range, down to cryogenic temperatures. Microsanj has imaged gold contact layers with sub-micron spatial resolution from 10 K to 800 K. For measurements below 5–10 °C, use a cryostat with an optical window to avoid water condensation on the sample.

Referenced Publications (bibliography, as listed in the source manual)

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`[diagram/image in source — not reproduced here: Appendix B, Section 13.1 "NT220/NTIR220 CCD Camera" — heading present in source with no accompanying text, only a figure/image placeholder]`

Source Documents

Source Documents

This reference was generated from: **"Nano Therm User Manual V3.2"** (source PDF, text-extracted; original file: `Nano Therm User Manual V3.2 [source-pdf].txt`), Microsanj LLC, © 2025. All specifications, procedures, and part numbers above are drawn directly from that source document; content the extraction could not reliably render (photos, screenshots, wiring/timing diagrams, and one jumbled optical-heads table) is flagged inline above rather than guessed at.

Operation

Project Manager

Project Manager

Launch SanjVIEW from the Windows 10 start screen shortcut; once the license verifies, the Project Manager window opens. From here you can select:

- **Transient Thermoreflectance** (TR only): acquires transient thermal images for pulses between 50 µs and 5 ms. Available only with the Visible Camera.
- **Movie Mode**: acquires quasi-steady-state thermal images for pulses longer than 5 ms.
- **FA Mode**: simplified quick-analysis mode for fault localization.
- **SanjANALYZER**: performs advanced analysis on previously acquired data.

Key features of the Project Manager window:

- **Operation Select Buttons** — single-click to open Transient Thermoreflectance, Movie Mode, FA Mode, or SanjANALYZER.
- **System Status** — indicator lights show communication status per instrument (green = communicating; off/white = not communicating).
- **LED Brightness** (TR only) — check "Auto" to let the computer self-adjust image brightness.
- **Camera Selection** — choose between the turret-mounted Infrared (IR) camera and the Visible or Near-IR camera. Use the **F1** hotkey to switch quickly.
- **Workspace Path Selection** — File → Options → Software, to set the workspace file path used across SanjVIEW modules.
- **Image Intensity Graphs** — average image intensity plus a histogram option, to help keep pixels below saturation.
- **Image Display Window** — shows the live camera stream; brightness/light source controlled by the Illumination Controls.

Beginning thermal imaging on a new device:

1. Place the device under test (DUT) on the probe station.
2. In Project Manager, confirm all components show a green status light (unless the NIR camera is unavailable).
3. Select the desired illumination option and "Channel Number," and focus the microscope. A live DUT image appears on the right of the screen.
4. Check the "Auto" box under LED Brightness for automatic brightness optimization (Visible Camera only).

Note: When imaging with infrared light (IR), Transient Thermoreflectance options are unavailable, and LED illumination is disabled during an IR imaging session.

Viewing temperature response in DC mode: while Project Manager is running, approximate temperature values display on the camera measurement window, scrolling as an average of the drawn Region of Interest (ROI) (or the whole image if no ROI is drawn). Use the rectangle tool to draw an ROI. DUT bias controls let you select outputs and voltage while acquiring images; the TC-100 stage can be used (~100 mA/V), or the Relay output can be selected from the pulldown. Select the TC-100 tab and press "TC-100 State on" to read the thermocouple value (useful for setting IR camera gain). Right-click the image window to save the acquired image and its color palette.
`[diagram/image in source — not reproduced here: Figures 1–3, Project Manager and DC mode window screenshots]`

Transient Thermoreflectance (TR)

Transient Thermoreflectance (TR)

Acquires new thermal imaging data for pulses between 50 µs and 5 ms (transient).

Key features:

- **Mode Selector** — Device Setup (optimize brightness/focus, no thermal image shown) vs. Thermal Imaging (begin acquisition).
- **Camera Image Display** — live DUT image; zoom tool (SHIFT-CLICK to zoom out).
- **Output Voltage Control** — voltage to device and output source.
- **Illumination Control** — LED pulse width (image integration time for a thermal event); adjust acquisition period (total cycles per image) if brightness is off.
- **Time Delay Control & Timing Parameters** — controls when in the heating cycle the "snapshot" image is taken.
- **Thermal Image Display** — calculated thermal image using the entered thermoreflectance coefficient; scale bars compress the scale to see detail despite shadows.
- **Region Mean Graph** — history of measured ROIs; ideally points differ by less than 5% before stopping. Right-click → "clear chart" to reset.
- **ROI Statistics**:
  - Temperature Value — ROI ΔT for the current image.
  - CTR — the thermoreflectance coefficient, constant per substance; must be entered correctly and must correspond to the active Channel Number (wavelength). Example values given in the source: Channel 6 (530 nm) CTR = 2.5E-4; Channel 6 (470 nm) CTR = 1.6E-4 *(source lists both as "Channel 6" — verify wavelength/channel mapping before relying on this)*. CTR may also be called "Cth."
  - Scale Bars — zoom the temperature scale; note the ROI mean tool may be inexact when limit bars coerce data into range.
  - ROI Tools — rectangle, annulus (zoom/magnification), freehand region, point tool.

Example procedure — obtaining a transient measurement:

1. Turn off "Int Vo 20mA Range" in the Project Manager.
2. Set "DUT Pulse" to the desired pulse width (example: 500 μs).
3. Set "Voltage to Device" (example: 6.0 V) and select "Update Values."
    1. Switch to "Thermal Imaging" mode.
    2. Confirm the device is heating as expected for the 500 μs delay.
4. Set "Image Delay(s)" to 0 to initialize delay to 0 μs (you can start at any initial delay time).
5. Go to File → Setup Sweep.
6. Enter "Number Delay Images" (example: 51).
7. Enter "Delay Steps(s)" (example: 10.0 μs) — software will take 51 images at 10 μs steps starting at 0 s (0–500 μs).
8. Enter "Ave time per frame(s)" (example: 5 s per image).
9. Enter the "Base File Name" to save under.
10. Select an ROI with the "Draw ROI" tool.
11. Press "Start."
12. The software steps through the thermal transient automatically and shuts off voltage on completion. A thermal image is averaged and saved at the configured interval (example: every 5 s; 255 s total for 51 points, 4 min 15 s).
13. Once done, exit and open the saved data in SanjANALYZER.

The transient response of an ROI can be watched live in the "Region Mean Graph" tab (lower-left) by selecting a region with "Draw ROI."

Movie Mode (TR and IR)

Movie Mode (TR and IR)

Acquires quasi-steady-state thermal images for pulses longer than 5 ms. Used to view longer-timescale IR and TR waveforms. In TR mode, SNR may be reduced relative to Transient/FA modes — localize thermal events first, then use Movie Mode for further study.

Key features:

- **Camera Image Display** — Zoom, Grab, and ROI selector tools (SHIFT+CLICK to zoom out).
- **Time Domain & Frequency Domain Graphs** — average of ROI pixels over time or frequency; sweep with the frame number control.
- **Device Controls** — the EZ500A SanjCONTROLLER drives two outputs: Voltage Out (Output 1, primary, modulated in sync with the camera) and Output 2 (constant source for powering other circuit parts). Changes apply on "Update Values." Pulse timing duration is adjustable.
- **Waveforms Graph** — shows output voltage/current when "Controller Box" is the selected output source.
- **Thermal Image Display** — shown in relative units (1e-4 dR/R) or temperature (via CTR). Draw an ROI in Thermal Imaging mode to see the averaged temperature value.
- **Region Temperature**:
  - ΔT (°C) — up to 5 different ROIs.
  - CTR or E — thermoreflectance coefficient (material-dependent) or, for IR sessions, Emissivity (E).
  - Scale Bars — active when Autoscale is off; palette selector for visualization; binning modes 2X and 4X improve SNR.
  - ROI Tools — rectangle, annulus, freehand, point.
- **Save Data** — choose file name/path; comment text box appears when the file is reopened in the Thermal Image Analyzer.

Setting the time window: Options → Software tab → "Movie Mode Length" dropdown; sets the averaging time window to 3–30 seconds.

Example procedure — obtaining a Movie Mode image:

1. Connect the DUT to Voltage Out (AUX Output optional).
2. Select biasing conditions via the "Device Control" panel and click "Update Values."

3. While the image averages, use the ROI tool, scale bars, and Thermal Image Display tool to optimize the image.
4. Once the desired thermal image is achieved, save a data file for further analysis and output.

FA Mode (TR and IR)

FA Mode (TR and IR)

A simplified differential-imaging mode for quick fault localization.

Key features:

- **Camera Image Display** — grab (hand), zoom (magnifier, SHIFT-CLICK to zoom out), and area select (square, used with the merged image to crop to ROI) tools.
- **Output Voltage Control** — device voltage and output source.
- **Camera Histogram** — brightness, set previously in Project Manager.
- **Thermal Image Display** — calculated thermal image; scale bars compress the scale.
- **ROI Statistics** — Temperature Value (ΔT); CTR or E (material coefficient, user-entered); Scale Bars; ROI Tools (rectangle, annulus, freehand, point).
- **Region Mean Graph** — history of measured ROIs; ideally within 5% before stopping; right-click "clear chart" to reset.

Calibration — Quick Start

Calibration — Quick Start

Calculates the thermoreflectance coefficient (TR) or emissivity (IR) of specific device surfaces. Accurate temperature readings depend on a coefficient obtained via calibration. Coefficient maps can be produced for point-by-point calibration. The module thermally cycles the DUT while reading the thermocouple back, continuously averaging coefficients across cycles to raise SNR.

Key features:

- **Camera Image Display** — grab, zoom (SHIFT-CLICK to zoom out), and area select tools.
- **Hardware** — Thermal Chuck Settings (current to TCAT-100 stage, changeable via Options in Project Manager); Microscope Settings (objective magnification, set in Project Manager).
- **Timing/Illumination** — Thermal Time Constant (hot-cycle duration); Image Averaging (#/cycle).
- **Brightness** — adjust for a bright-but-not-saturated image (saturation at 4095 units); Auto Brightness available; "Good Illumination" indicator turns green when illumination is sufficient for good SNR.
- **3D Alignment (TR only)** — Image Auto Alignment detects and corrects image shift during a run (reduces edge effects). Alignment Reference sub-controls: Focus ROI (region to track — pick an area easy to detect a shift in, e.g. a corner), Capture Reference (reference image to shift back to), Focus Tolerance (in-focus threshold on slope), Alignment % (increase to improve accuracy), Vibration Filter (decrease to improve accuracy).
- **Thermal Image Display** — main C^{tr} image; C^{tr} of all materials present is calculated and shown.
- **System Status / TCAT Image Parameters** — chosen measurement parameters, elapsed cycle time, heating/cooling status.
- **C^{tr} or Emissivity Graphs** — Camera Data (intensity, should not vary significantly during measurement, shows hot/cold-cycle transitions); Temperature (thermocouple readout, tracks hot/cold cycle); ROI History (C^{tr} history for a specific ROI, to check stability across cycles); ROI histogram (C^{tr} distribution across all pixels in the ROI, for consistency checking).
- **Area Statistics** — C^{tr}/Emissivity and associated data (incl. thermocouple temperature) for the selected ROI.
- **Save Image** — file name/path; comment text box shown when reopened in the Thermal Image Analyzer.

Verifying calibration using TCAT-100 in pulsed mode: set up a test sample as for calibration, launch Pulsed Mode software, select TCAT-100 as the output device, and enable thermocouple readback to simultaneously display the thermocouple signal alongside TR or IR measurement data. Calibrated IR camera results should closely overlap thermocouple results. Note: the thermocouple used with the TCAT module has a response time of ~0.5 s, so it may be necessary to lengthen the timescale to see an accurate response.

SanjANALYZER™ — Thermal Image Analyzer

SanjANALYZER™ — Thermal Image Analyzer

A fully integrated analysis package for low-frequency and transient thermal imaging data. Capabilities:

- View previously acquired thermal images
- Correct for thermoreflectance coefficients
- Utilize point-by-point calibration maps
- Find area mean temperature values
- Create and save cross-section plots
- Output images in various formats
- Create .avi movies from an image series (SanjANALYZER Plus only)

Key features:

- **Load a Thermal Image** — low-frequency data uses `.fdi`; transient data uses `.tti`. Double-click a file in the file selection control to load the CCD and thermal images.
- **CCD Image Display** — grab, zoom (SHIFT-CLICK to zoom out), area select tools.
- **Primary Thermal Image Display** — viewing modes: Thermal Image VIEW, Merge VIEW, and optional 3D VIEW (SanjANALYZER PLUS).
  - **Thermal Image VIEW** — calculation using masking info or a single coefficient. ROI Mean/Statistics: select a shape or freehand region for mean temperature (selection also shows on the CCD image). Cross-Section Graph: draw a line to plot temperature vs. distance (masked/invalid points excluded); select the correct Objective for accurate scale; save in ASCII (tab-delimited). Limit Bars: coerce auto-scaled data to selected limits (also affects Merge and 3D views). Color Palette Selection: multiple palettes, saved with exported images. Software Binning (x2 or x4): spatial averaging to improve faint images or cross-section SNR, at the cost of spatial resolution.
  - **Merge VIEW** — for display/saving only (temperature values live only in the thermal image). Converts to RGB for compatibility with image output formats.

CCD/Thermal/Thermal Image slide bars: first slider overlays % of CCD image on the thermal image (to locate hotspots precisely); gain/offset sliders apply to the thermal image (100%/0% = unchanged).

- ◦ **Crop from CCD Image checkbox** — crop the thermal image away from the ROI, useful for reducing .avi movie file size.
- ◦ **Fix Temperature Scale checkbox** — keeps a previously set scale fixed across a loaded series (recommended workflow: find the hottest image in the series, set the desired scale, check "fix scale," return to the first image, and run "process series").
- ◦ **Show Voltage / Delay / Color bar checkboxes** — overlay acquisition conditions and the color-to-temperature mapping on the image.

Example procedure — analyzing a transient thermoreflectance image series:

1. Select the first image of the transient series.
2. Enter the "number of images in the series" (example: 51).
3. Select an ROI box on the area of interest (example: a 5 μm gold heater).
4. Select "Process Series." The software steps through the series and plots data in "ROI Mean Series" (bottom left); right-click the y-axis to autoscale.

Output Module

Output Module

See the Output Module Signal Reference table in Specifications for pin functions (VI EXT, VO EXT, AUX INT, VO INT, VO INT 20mA Range, TRIG).

Operating SanjVIEW 7 with the Visible Camera (TR)

Operating SanjVIEW 7 with the Visible Camera (TR)

Opening and initial setup:

1. Open SanjVIEW v7.0 from the Computer desktop.
2. Center the sample in Project Manager and focus on the desired device.
3. Confirm all indicator lights are green for your connected system.
4. Select the camera to use (Infrared / Visible-Thermoreflectance / Near-Infrared). Press **F1** to switch cameras.
5. Click the Auto Focus tab.
6. Set "Mag" to your objective (example: 5X).
7. Click "Enable Motion" ON and "Center Stage" ON. (Note: the microscope may need refocusing after centering the stage.)
8. Click the file icon; name your file path and click "current folder."
9. Select the desired imaging operation.

Note: Transient Thermoreflectance is not available with an Infrared camera selected — it requires the Visible camera.

Steady State:

Hardware:

1. Enter the desired Base Temp (°C) and click "SET" next to Set Base Temp.
2. Set Stage State "ON."
3. Set "Vo ON Voltage" to 7V.

Timing/Illumination:

1. Set Device On Time to 10.

2. Set Image Averages (#/cycle) to 10.

3D Alignment — Focus ROI:

1. Select a region on the CCD image with the rectangle tool (choose a unique feature, e.g. an edge or scratch mark).
2. Press "Focus ROI" to set the selected region as your ROI.
3. Wait until the Focus ROI light turns green. (Zoom: hold SHIFT to zoom out, SHIFT+CLICK to zoom in.)
4. Confirm "Enable 3D NanoAlign" is checked; check it if not.

3D Alignment — Capture Reference:

1. After the ROI focuses, press "Capture Reference" to set the reference region.
2. Wait for the Capture Ref light to turn green ("Enable Digital Anti-vibration" turns on automatically).
3. Set initial Focus Tolerance, Alignment %, and Vibration Filter parameters — lights turn green when in range. (Increasing Alignment % and decreasing Vibration Filter improves alignment accuracy. Alternatively, load a prior reference.)

Start Measurement:

1. Click "START Measurement."
2. Progress shows in the System Status bar ("Turn OFF" after each cycle) with a "Loop Iterations" count. For TR, 9–11 loop iterations is sufficient.
3. Under Save Path, confirm the directory/name (example: `C:\Data\Qualification\`); append a filename.
4. Click "Save Every Cycle," then click "Save Data" when ready. (Save the image before stopping the measurement.)
5. To stop: click "STOP MEASUREMENT," then "Return to Project Manager," or File → Quit.

Calibration:

Hardware:

1. Set "Magnification" to match the objective (example: 5x).
2. Set "High Temp" to 120 °C and "Base Temp" to 20 °C.
3. Turn "Stage State" ON.
4. Click "Set Low Temp" to initialize the chuck to the base temperature.
5. Click "Use Chuck Sensor" to use the embedded chuck thermal sensor for calibration (off = use an external thermal probe).

Timing/Illumination:

1. Set Stage Heating Time to 40.
2. Set Image Averages to 50.

3D Alignment — Focus ROI / Capture Reference: same procedure as Steady State above.

Start Measurement:

1. Click "START Measurement." The system cycles through temperatures, showing "Calibration Done" after each cycle and a Loop Iterations count.
2. Select the region on Thermal Image View to view the Calibration Factor (shown in "Mean CTR").
3. Under Save Path, confirm directory/name (example: `C:\Data\Qualification\Training`).
4. Check "Save Every Cycle," then click "Save Data." (Save before stopping.)
5. Stop via "STOP MEASUREMENT," "Return to Project Manager," or File → Quit.

Failure Analysis (FA) Mode:

Parameter Setup:

1. In Project Manager, change "Cam Selection (F1)" to "VISIBLE."
2. Uncheck "INT Vo 20mA Range" (green = checked, grey = unchecked).
3. File → Options to open a new window.
4. Software tab → set "FA Mode Pulse Width" to Long (15 Frames).
5. Return to Project Manager, click "FA Mode" to open the FA Mode window.

Process: (confirms the device is biased and current is flowing, before using Movie or Transient mode)

1. Go to the "Biasing" tab.
2. Change Vo(V) to 7.000.
3. Click "Update Values" to apply voltages.
4. Check that "Peak Voltage (V)" and "Peak Current (I)" read near 7V and 70 mA for device 2 (Center Diode). (If current is much lower than expected, confirm "INT VO 20mA Range" is unchecked in Project Manager.)

Save Data:

1. File → Save Data.
2. Click File Browser, select the target folder, click "Current Folder" (example: `C:\Data\Qualification\Training`).
3. Enter the desired file name (example: "FA-File").
4. Click "Save."
5. Click "Return" to exit the Save Microsanj Data pop-up. (Remember to update the Microsanj Data Save Path before a new dataset, to avoid overwriting prior data.)

Transient Thermoreflectance:

System Status:

1. Change camera to VISIBLE.

2. Click "Transient Thermoreflectance."
3. Click the "Measurement Settings" tab.

Measurement Setting (alignment — two approaches):

First approach (Focus Region + Capture Reference):

1. Select a region on the CCD image with the rectangle tool (unique feature, e.g. edge/scratch).
2. Press "Focus ROI"; wait for the Focus ROI light to turn green.
3. Press "Capture Reference"; wait for the Capture Ref light to turn green.

Second approach (Load Reference):

1. Click "Load Reference."
2. Enter the calibration file path (browse icon), then click "LOAD."
3. Wait for the "Load Reference" light to turn green.
4. Click "Enable 3D Motion" and "Enable DAV."
5. Set "Alignment %" to 99.00.

Transient Thermoreflectance — single image: (thermal image should appear before proceeding)

1. In Measurement Settings, set "Voltage to Device (V)" to 7V.
2. Click "Update Values" to apply voltages.
3. Review the auto-populated "DUT Pulse," "LED width," and "Acq Period" values (changeable, but left as-is in this example).
4. Click "Start Measurement."
5. Wait ~30 s or until noise averages out, then File → Save Data.
6. Click File Browser, choose the save location, enter a file name, click "Save."
7. Click "Measurement Running" to stop.

Transient Thermoreflectance — series:

1. Set "Voltage to Device (V)" to 7V.
2. Click "Update Values."
3. Review auto-populated "DUT Pulse," "LED width," "Acq Period" (changeable).
4. Set "Image Delay" to 0s; click "Update Delay."
5. Go to File → Setup Sweep.
6. Click File Browser, choose the save location ("current folder"); append the desired file name.
7. Enter "Number Delay Images" (example: 10).
8. Enter "Delay Step" (example: 50 µs — the DUT Pulse increment per frame).
9. Enter "Ave time per frame" (example: 30 s).
10. Click "START" to begin thermal imaging and data collection.
11. When the designated number of images has been collected, the "start" button turns green again; click "close" to exit the dialog, then click "measurement running" to stop the process.

SanjAnalyzer (Visible camera path):

System Status:

1. Confirm camera is set to VISIBLE.
2. Click "SanjAnalyzer" to open the "SanjVIEW Image Analyzer" window.

Process Data:

1. Select the "Calibration" tab.
2. Select "Point to Point" under the "Method" dropdown (opens a "Load CTR Map" window).
3. Click the Browse icon and select the calibration image.
4. Click "LOAD" to overlay the calibration image onto your selected test image.
5. In the file window (top left), click the Browse icon and double-click the file to analyze. (If the file is not listed, update the directory with "UP Dir.")
6. Drag an ROI box across the specimen with the rectangle tool to measure temperatures (up to 5 ROI boxes; hold Ctrl to select additional boxes).
7. Adjust temperature scale and image averaging factors as desired (optional).
8. Select the "Settings" tab, choose a save path (Browse icon), and click "Save Image Current View."
9. To process a series: enter the number of files into "Number of Images in Series" and click "Process Series." The ROI Mean graph plots mean temperature of the selected ROIs over time. (Right-click the graph → Export → "Export Data to Clipboard" to export the data to a table.)

Device Biasing, Trigger Function, and Timing

Device Biasing, Trigger Function, and Timing

See the Device Biasing / Trigger Connectors table (Specifications) for the SanjCONTROLLER PLUS™ connector functions (VI EXT, VO EXT, AUX INT, VO INT, TRIG).

`[diagram/image in source — not reproduced here: Section 9.2–9.8 — timing sequence diagrams for transient analysis, internal biasing, external DC supply, triggering an external source, Slave Mode (TRIG IN, Movie Mode only), transient timing signal, and transient software with light emission]`

SanjVIEW 7 for Near Infrared (NIR) Camera

SanjVIEW 7 for Near Infrared (NIR) Camera

SanjVIEW 7 provides the same functionality for Visible and NIR cameras, provided the camera selection (F1: VISIBLE/NIR) is compatible with the LED selection (F3). See the Camera/LED Compatibility table in Specifications.

SanjVIEW 7 for Infrared (IR) Camera

SanjVIEW 7 for Infrared (IR) Camera

Opening and initial setup:

1. Open SanjVIEW v7.0 from the Computer desktop.
2. Center the sample in Project Manager and focus on the desired device.

System Status:

1. Confirm all indicator lights are green for your connected system.
2. Select the camera to use, then uncheck "INT Vo 20mA Range" to bypass the 20 mA current limit.
3. Click "Temp Control" tab; toggle ON/OFF and view readings for Stage, Thermal Coupler (TC), and ROI. Set Point to 75, then click "Stage State" to turn on the stage.
4. Click "Auto Focus" tab; select objective magnification (example: 5X).
5. Click "Center Stage" ON to center the Piezo controller or other external autofocus controller (only if applicable). (Note: the microscope may need refocusing after centering.)
6. Click the file browser icon, choose the save folder, click "Current Folder."
7. Select the desired imaging operation.

Note: Transient Thermoreflectance is not available while using an Infrared camera.

Steady State: (Project Manager → "Steady State")

Hardware:

1. Enter the desired Base Temp (°C) (example: 75) and click "SET" next to Set Base Temp.
2. Turn Stage State "ON."
3. Set "Vo ON Voltage" to 10V.

Timing/Illumination:

1. Set Device On Time to 10.
2. Set Image Averages (#cycle) to 10.

3D Alignment — Focus ROI / Capture Reference: same procedure as the Visible-camera Steady State workflow above.

Start Measurement:

1. Click "START Measurement."
2. Progress shows in the System Status bar ("Turn OFF" after each cycle) with a Loop Iterations count. (If red indicator lights appear in System Status, adjust the Alignment Reference.)
3. Under Save Path, confirm directory/name; add a filename prefix (example: `C:\Data\Qualification\SS`, prefix "SS").
4. Click "Save Every Cycle," then "Save Data" when ready. (Save before stopping.)
5. Stop via "STOP MEASUREMENT," then "Return to Project Manager," or File → Quit.

Calibration: (Project Manager → "Calibration")

Hardware:

1. Set "Magnification" to match the objective (example: 5x).
2. Set "High Temp" to 120 °C and "Base Temp" to 75 °C.
3. Turn "Stage State" ON.
4. Click "Set Low Temp" to initialize the chuck to the base temperature.
5. Click "Use Chuck Sensor" to use the embedded sensor (off = external thermal probe).

Timing/Illumination:

1. Set Stage Heating Time to 40.
2. Set Image Averages (#cycle) to 50.

3D Alignment — Focus ROI / Capture Reference: same procedure as above.

Start Measurement:

1. Click "START Measurement." The system cycles through temperatures, showing "Calibration Done" after each cycle and a Loop Iterations count.
2. Select the region on Thermal Image View to get the Calibration Factor (shown in "Cal Fact").
3. Under Save Path, confirm directory/name (example: `C:\Data\Qualification\CAL`, prefix "CAL").
4. Click "Save Every Cycle," then "Save Data." (Save before stopping. If the thermal image is blurry, adjust Alignment Reference.)
5. Stop via "STOP MEASUREMENT," "Return to Project Manager," or File → Quit.

Movie Mode: (Project Manager → "Movie Mode")

Control Settings:

1. Set "Voltage Out" to 10V.
2. Click "Update V" to apply voltages.
3. Set "DUT Pulse (s)" (example: 1s); click "Update Timing."
4. Confirm "Save Whole Series" is on (default).
5. Click the "File Path" icon or type the desired path; select a name.
6. Click "Start Movie" on the "EZ500 Movie Mode Acquisition" panel.
7. Click "Save Image." (Note: Movie Mode saves a series of 105 files per cycle when you click "Save Image.")
8. To stop: click "Start Movie" to stop, then File → Exit.

SanjAnalyzer (IR path):

System Status:

1. Confirm camera is set to INFRARED.
2. Click "SanjAnalyzer" to open the "SanjVIEW Image Analyzer" window.

Process Data: same workflow as the Visible-camera SanjAnalyzer procedure above (Calibration tab → Point to Point method → load CTR map → select analysis file → draw ROI box(es) → adjust scale/averaging → Settings tab → save/process series).