



Operators' Manual Glass Tempering Scanner

Version 2026-09-A

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1 General Notes

1.1 Intended Use

Thank you for choosing the optris® Glass Tempering Scanner (GTS).

This compact system is ideal for measuring glass from beneath and can be used for process control in glass tempering machines. This system consists of several components which are already pre-wired and ready for immediate use. The system runs on 24 V, supplied by 100 - 240 V_{AC} and is connected to a PC via an Ethernet cable. With the license free analysis software PIX Connect and a predefined layout the system can be used directly.

Features:

- Bottom-up measurement system with breakage detection sensor.
- Digitally controlled lens protection system (DCLP) avoids additional air purge and protects the camera lens.
- Automatic calculation of the glass area.
- Pre-assembled standalone system for easy installation on existing glass tempering furnaces.
- Standalone operation: no direct trigger signal from the furnace control system is required. Triggering via the furnace control system remains possible, while the supplied furnace door sensor enables independent operation.



Please find more information on this product and all available material on our website:

<https://optris.com/products/infrared-application-packages/glass-inspection-systems/glass-tempering-scanner/>

1.2 Warranty

Every product undergoes a comprehensive quality assurance process. Nevertheless, if a failure occurs, please contact customer service immediately.

The warranty period is 24 months from the date of delivery. After the original warranty period has expired, the manufacturer provides an additional 6-month warranty on all repaired or replaced components. The warranty does not cover damage resulting from misuse, improper handling, or neglect. The warranty also becomes void if the product has been opened without authorization. The manufacturer shall not be liable for consequential damages or for damages resulting from unintended use of the product.

If a failure occurs during the warranty period, the product will be replaced, recalibrated, or repaired free of charge. Shipping costs must be covered by the sender. The manufacturer reserves the right to replace individual product components instead of repairing them. If the failure is caused by misuse or neglect, the user will be charged for the repair. In such cases, a cost estimate can be provided upon request.

All infrared measurement systems from Optris undergo extensive end-of-line testing before delivery. This final quality control process ensures that every product meets strict performance and reliability standards. Through rigorous testing of each unit, accurate and reliable operation in accordance with Optris specifications is ensured.

1.3 Maintenance



NOTICE

Cleaning

Never use cleaning compounds which contain solvents (neither for the lens nor for the housing).

1.3.1 Cleaning

Blow off loose particles using clean compressed air. The lens surface can be cleaned with a soft, humid tissue (moistened with water) or a lens cleaner (e.g. Purosol or B+W Lens Cleaner).

1.3.2 Handling

When cleaning the optics of the infrared measurement device, gloves must be worn at all times when handling lens materials. Some infrared-glass (IG) lens materials may be toxic and can be absorbed through the skin. Care must be taken when handling all IG materials, as they are soft and susceptible to scratching.

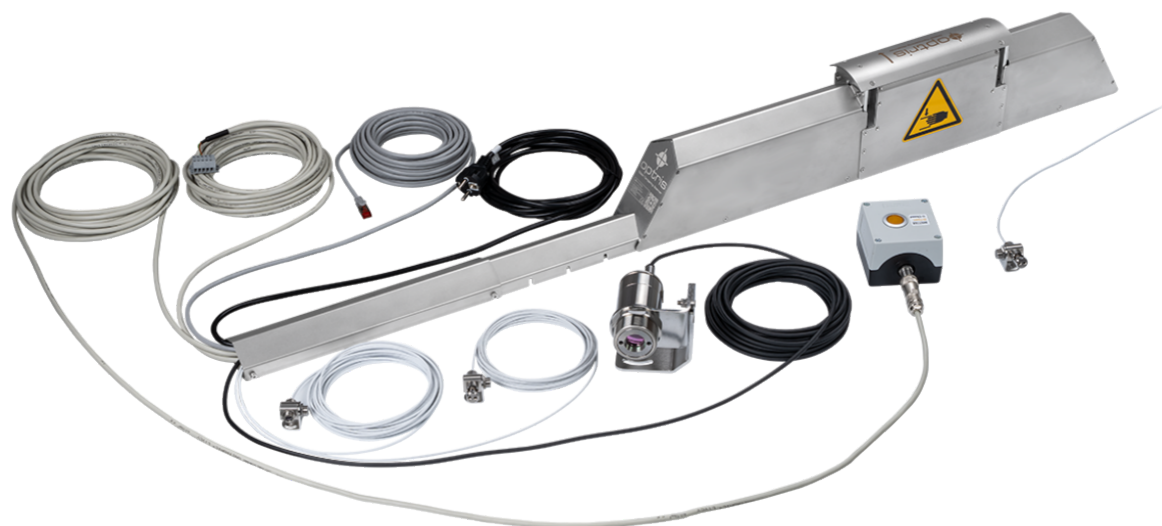
Do not swallow or inhale particles or dust from infrared lens materials. In the event of fire and/or explosion, avoid breathing fumes. High temperatures may release toxic selenium oxide and arsenic-containing fumes. Contact with acids may release toxic hydrogen selenide gas.

1.3.3 Storage

Infrared cameras, especially the optics, should be stored in a low-humidity environment. Extended exposure to UV light should be avoided, as it may cause surface hazing of the optical components. Contact with high temperatures, strong acids, or bases should also be avoided.

1.4 Scope of Supply

- GTS main unit (pre-assembled) with shutter for emergency closure, electronics and PI 640i G7 with 120° optics
- Ethernet cable, 10 m
- 100 - 240 V_{AC} Power supply cable (US and EU), 5 m
- Glass breakage sensor (CTlaser 4M), 10 m
- Furnace door sensor (CTi LT), 10 m
- Analog input cable, 10 m
- Aiming support with 10 m cable (2 pcs.)
- Cable protection conduit (4 pcs.)
- Optional: remote control button with 10 m cable



Picture 1: Scope of supply of optris Glass Tempering Scanner.

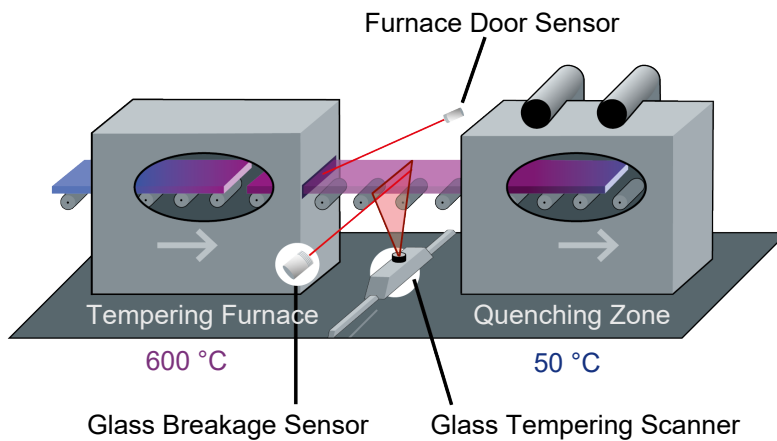
2 System Description

2.1 Functional Principle

Glass tempering is a thermal process used to increase the strength and safety of glass. During the process, the glass is heated to a high temperature and subsequently cooled rapidly under controlled conditions.

The glass sheet moves through a tempering furnace on ceramic or metal rollers. Inside the furnace, the glass is typically heated to temperatures of approximately 600 °C. Uniform temperature distribution across the entire glass surface is essential, as temperature differences can lead to uneven mechanical stress distribution and reduced optical quality.

After the heating process, the glass enters the quenching section, where it is rapidly cooled to approximately 50 °C using high-pressure air.



Picture 2: Example of Glass Tempering Furnace with Optris GTS, Glass Breakage and Furnace Door Sensor.

The Optris Glass Tempering Scanner (GTS) is designed for continuous monitoring of the glass surface temperature after the heating process. The system helps to ensure correct tempering, uniform stress distribution, and consistent optical quality.

The GTS is installed below the open section between the heating furnace and the quenching section and monitors the glass as it exits the furnace. In addition to the infrared process imager, the system includes a sensor for detecting the opening of the furnace door and a glass breakage sensor, which initiates emergency shutter closure if required.

The system measures the glass temperature distribution from below. In most tempering processes, the coated side of the glass faces upwards, while the uncoated side faces downwards. Measuring from below provides more stable emissivity conditions, reduces reflection errors, and enables more accurate temperature measurement across the glass surface.

After correct installation, a detailed view of the glass temperature is displayed.



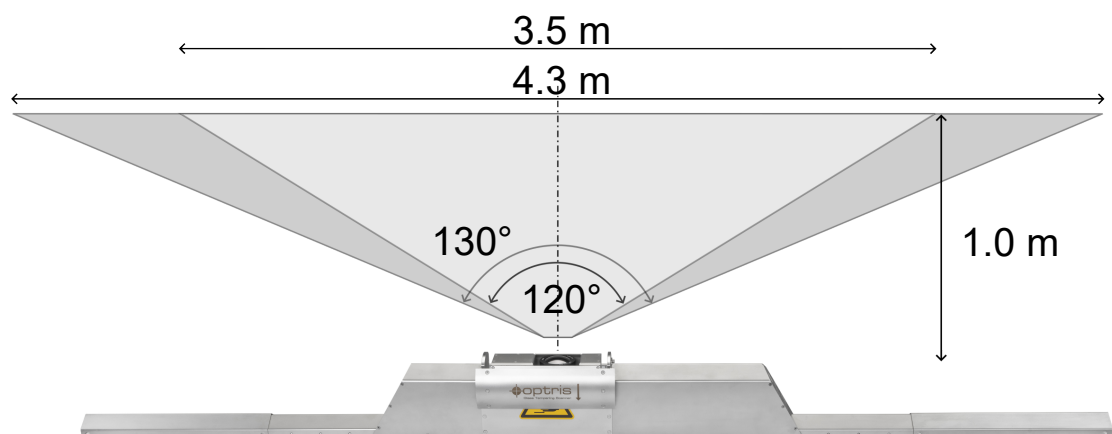
Picture 3: Example of glass sheets recorded with Optris Glass Tempering Scanner (GTS).

2.2 Schematic Setup

The Optris Glass Tempering Scanner (GTS) uses an infrared camera equipped with a 120° lens. By using the integrated line scan function, the system generates a complete thermal image of the entire glass sheet during the tempering process.

With the system installed on the floor approximately 1 m below the glass, the system provides a horizontal field of view (HFOV) of up to 3.0 m while operating at a frame rate of 125 Hz. This configuration covers the requirements of most standard glass tempering furnaces.

For applications requiring the measurement of wider glass sheets, a diagonal line scan configuration with a 120° lens is available. This setup enables a horizontal field of view (HFOV) of up to 4.3 m for a distance of 1 m between glass sheet and lens. However, this configuration is generally not recommended, as the frame rate is reduced to 32 Hz, resulting in lower temporal resolution and reduced measurement performance.



Picture 4: Field of view of process imager with 120 ° lens.

The system has the following components:

Trigger: oven	Analog input from oven. Always connect CTi LT22 simultaneously.
Trigger: CTi LT	Connection to CTi LT22 SF pointing at oven door as line scan trigger.
Glass breakage detector	Connection to CTlaser 4M FF for emergency closure.
LAN	Ethernet connection to operating computer.

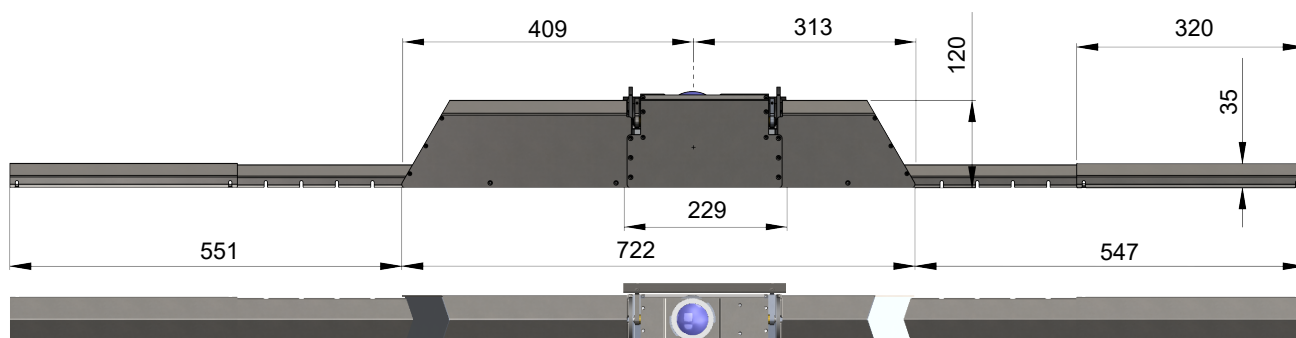
Remote Control	Connection to remote control unit for opening and closing the shutter and releasing the system from idle state after emergency closure (if purchased).
Heater	Connection to heating element to assist with alignment of the line scanner. The second heater is connected to the other side of the system. Heating elements can be controlled via CompactPlus Connect 3.26.xxx. and reach a temperature of up to 260 °C.
Air	Air input hose for cooling the system. Use technical, dry and oil-free air only. Use of unsuitable air will void the warranty.
110 V – 240 V AC	Power supply for the whole system.

Table 1: System Components

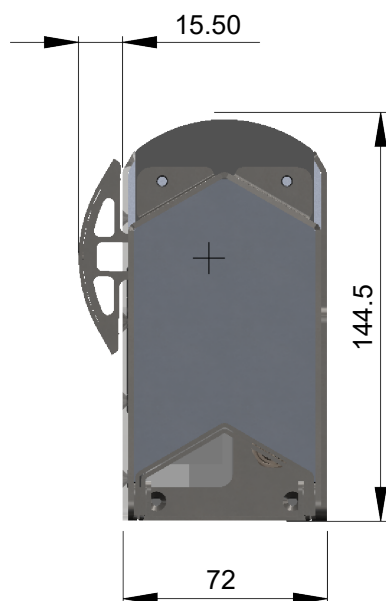
2.3 Mechanical Design

The following drawings show the mechanical dimensions of the Optris Glass System main unit. These drawings are intended to assist with system integration, mounting design, and installation. All dimensions are specified in millimeters (mm) unless stated otherwise.

When planning the installation, ensure that sufficient clearance is provided for the protective shutter to open fully. If the Optris Glass System is installed too close to the furnace or oven wall, the shutter may collide with the wall during operation, resulting in malfunction or mechanical damage.



Picture 5: Dimensions of the whole system [in mm], including rail protection housing for cables.



Picture 6: Cross-section of GTS system, dimensions in mm.

3 Technical Data

The following technical specifications apply to the Optris Glass System equipped with the following sensors: PI 640i G7 (120° lens), CTi LT, and CTlaser 4M.

3.1 Specifications

The following specifications apply to the whole system.

Specifications	Values
Environmental rating	IP32
Ambient temperature	0...45 °C (add. air cooling required above)
Storage temperature	-40...70 °C
Relative humidity	10...95 %, non-condensing
Material (housing)	Stainless steel
Dimensions	722 mm x 145 mm x 72 mm
Weight	23 kg (incl. all components)
Cable length (Ethernet)	Up to 100 m. We recommend Cat.6 or higher.

3.2 Factory Default Settings

The Optris GTS is delivered fully preconfigured and prewired with factory default settings optimized for typical glass industry applications. The system is designed as a ready-to-use solution and only requires a suitable power supply and a connection to a computer for operation.

Particular attention should be paid to the temperature threshold values configured for the CTlaser 4M and CTi LT sensors. These thresholds control the automatic opening and closing of the protective shutter and are critical for reliable system operation. Before commissioning, verify that the factory-defined threshold values are appropriate for your specific process and installation. Depending on the application, the threshold values may need to be adjusted to ensure correct shutter operation and optimum measurement performance.

Pyrometer	Function	Threshold value
CTlaser 4M	Glass breakage sensor	80 °C
CTi LT	Oven opening detection	400 °C

Table 2: Threshold values for emergency closure and oven opening

During commissioning, the CTlaser 4M threshold should be set to a high value, making sure the shutter is not triggered accidentally. Before operation, set the threshold back.

3.3 Optical Specifications

The following optical diagrams show the measuring spot diameter as a function of the distance between the sensing head and the measuring object. The specified spot size corresponds to 90 % of the detected infrared radiation energy, which is required to achieve a reliable temperature measurement.

The measuring distance is always referenced from the front edge of the sensing head.

3.3.1 Optics Calculator



Picture 7:
Optris Cal-
culator

As an alternative to the optical diagrams, the spot size calculator on the **Optris website** or the Optris Calculator App can be used. The app is available for free on the **Google Play** and **Apple Store**.

NOTICE! The size of the measuring object and the optical resolution of the infrared thermometer determine the maximum distance between the sensing head and the measuring object. To prevent measurement errors, the object should completely fill the field of view of the optics. Therefore, the measurement spot size should always be equal to or smaller than the size of the object.

3.3.2 CTi LT

The following table shows the pyrometer spot size as a function of the distance between the object and the pyrometer. The spot size corresponds to the minimum target size required for accurate temperature measurement.

The data are valid for the CTi LT 22 with a standard focus (SF) optics:

- Near Field Spot Ratio: 22:1
- Specified for 50.0 mm spot size at a distance of 1100 mm

Distance (mm)	0	100	200	300	400	500	600	700	800	900	1000	1100
Spot size (mm)	6.5	10.5	14.4	18.4	22.3	26.3	30.2	34.2	38.1	42.1	46.0	50.0

Please also refer to the manual of the CTi series available on our **website**.

3.3.3 CTlaser 4M

The following table shows the pyrometer spot size as a function of the distance between the object and the pyrometer. The spot size corresponds to the minimum target size required for accurate temperature measurement.

The data are valid for the CTlaser 4M with a far field focus (FF) optics:

- Near Field Spot Ratio: 30:1
- Far Field Spot Ratio: 5:1
- Specified for a spot size of 120 mm @ 3600 mm distance

Distance (mm)	900	1350	1800	2250	2700	3150	3600	4050	4500	5000	5400	6300	7200
Spot Size (mm)	45	57.5	70	82.5	95	107.5	120	137.5	155	172.5	190	225	260

Please also refer to the manual of the CTlaser series available on our **website**.

3.3.4 PI 640i G7

Find the optical data for the PI 640i G7 camera below, showing the different field of views as a function of distance between measured object and camera lens.

Angle	FOV	Distance				
		0.6	0.8	0.9	1	1.1
120 °	HFOV (m)	2.13	2.82	3.17	3.52	3.87
100 °	VFOV (m)	1.46	1.93	2.17	2.41	2.65
129.3 °	DFOV (m)	2.58	3.42	3.84	4.27	4.69

Table 3: Field of View at Distance to Measurement Object

The data above refer to the distance between the top of the camera and the glass sheet. Since the system itself has a height of 145 mm, this value must be subtracted from the installation height below the furnace.

For example, if the system is mounted on the floor 1,000 mm below the glass sheet, the resulting distance between the glass sheet and the camera is 855 mm.

- HFOV: Horizontal dimension of the total field of view at the object distance
- VFOV: Vertical dimension of the total field of view at the object distance
- IFOV: Measurement area represented by a single pixel at the object distance
- DFOV: Diagonal dimension of the total field of view at the object distance

Minimum measuring distance is 0.2 m. The accuracy of measurement may fall outside of the specifications for distances below the defined minimum distance.



NOTICE

Focusing of the camera

The user must ensure that the thermal channel is properly focused. This is necessary to obtain correct temperature values. If required, adjust the focus using the optics. Rotating the lens outward sets the focus to “near,” while rotating it inward sets the focus to “infinity.”

During focus adjustment, ensure that the emergency shutter closure is not activated, as the shutter may close unexpectedly and cause injury by pinching fingers. To minimize this risk, Optris recommends holding the shutter in the open position with your free hand while adjusting the focus. Always keep fingers away from the shutter's closing path.

Please also refer to the PI Manual available on our [website](#).

See also

- Schematic Setup [► 9]
- Schematic Setup [► 9]

3.4 System Requirements

A computer is necessary to run the Optris GTS system and the software PIX Connect, Compact-Plus Connect, the USB Redirector and WuTility.

The following minimum system requirements apply:

- Windows operating system
- USB 2.0 interface
- at least 2 GB RAM
- 2.0 GHz processor speed

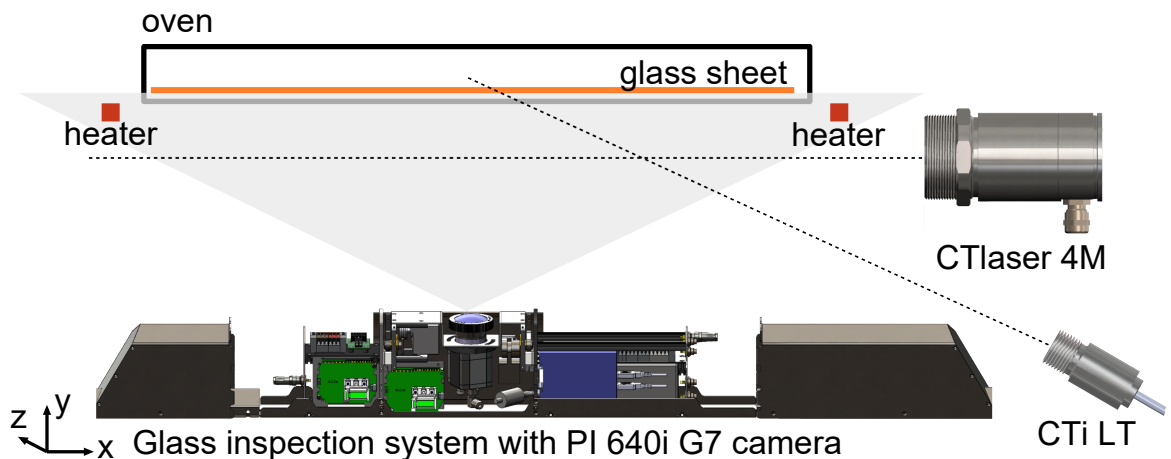
The recommended system requirements are:

- Windows 11
- at least 2 GB hard disk storage for IR videos
- at least 4 GB RAM
- 1 Gbps Ethernet port

4 Installation and Startup

4.1 Mechanical Installation

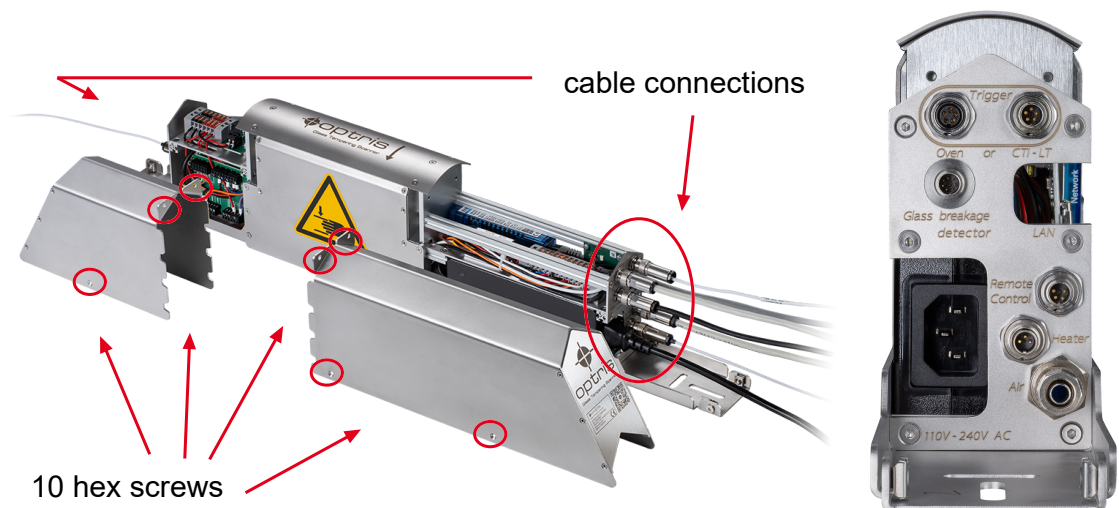
We recommend connecting all cables and verifying the connection to the computer before installing the system beneath the glass furnace. Once these checks have been completed, the main GTS system unit can be positioned approximately 90 cm below the glass sheets. The following section describes the installation procedure in detail.



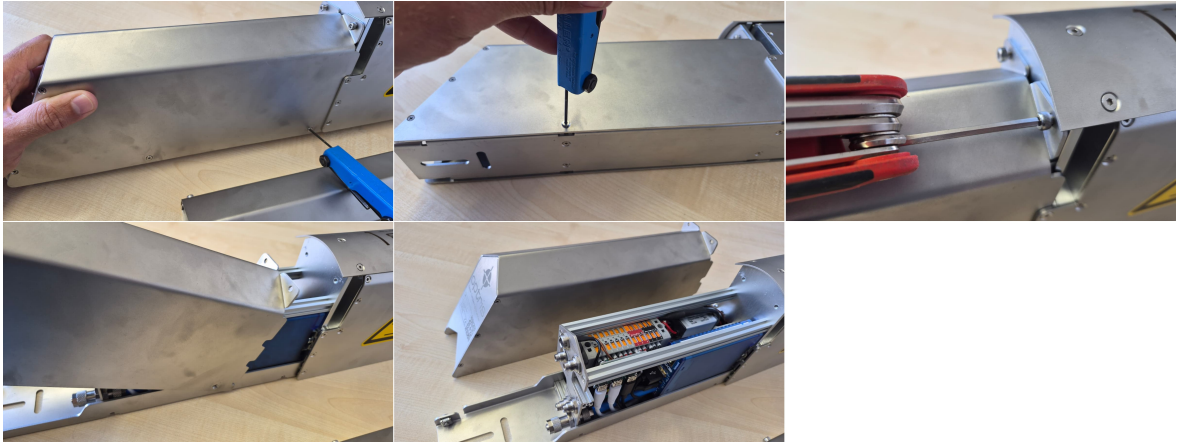
Picture 8: Sketch of mechanical installation

4.1.1 Cable Connection

Begin by connecting all cables and components. To open the housing, remove only the ten hex socket screws using an Allen key. Do not loosen the Phillips-head screws. They are intended for service purposes only and have been deliberately selected as a different screw type to prevent accidental removal.



Picture 9: Left: Remove hex screws as indicated to open the cover. Cables are connected to one side, except one of the heaters. Right: Front side of the system.



Picture 10: Unscrew hex screws and open housing.

After opening the housing, connect all cables according to the labeling. This includes the trigger from the oven door or the CTi LT pyrometer, the glass breakage sensor CTlaser 4ML, the remote control unit (if purchased), the 2 heaters (the one at the back is not visible here), the network connection via LAN cable, technical air and the power supply cable.

4.1.2 GTS main unit

After connecting all cables and verifying the network connection to the PC, install the GTS main unit on the floor beneath the glass furnace, between the heating furnace and the quenching zone. Secure the unit to the floor using the mounting holes provided in the housing.

Route all cables away from the area beneath the glass line using the supplied cable protection channels, and fit the upper covers securely. Do not leave any cables exposed below the glass transport system, as falling hot glass may cause damage. Damage resulting from incorrectly routed or unprotected cables is not covered by the warranty.

Caution: Verify focus alignment of the infrared camera at the target distance prior to installation in inaccessible locations. The factory preset focus distance is 855 mm.

4.1.3 Glass breakage sensor and oven trigger



Picture 11:
CTi LT -
Furnace
Door
Sensor

Ensure that the CTlaser 4ML glass-breakage sensor is installed correctly. The sensor triggers the emergency closure of the shutter to protect the infrared window from falling hot glass. Mount the sensor along the same axis as the GTS system, slightly below the glass sheets and between the rollers of the glass furnace. We recommend using the provided mounting bracket.

Install the CTi LT sensor such that it points at the furnace opening. Ensure that there are no objects in the optical path and the threshold is set correctly (see Section **Threshold Settings in Compact-Plus Connect** [► 19]).



Picture 12:
CTlaser -
Glass
Breakage
Sensor

The shutter can also be opened and closed via an analog input signal from the oven control system. Use the supplied cable for the analog input connection. Connect a normally open push button to the input. The input is activated by closing the contact. Reliable switching requires a clear voltage transition of at least 2 V. Depending on the purchased package, the shutter may also be operated manually using the button on the remote control unit.

Caution! When using the oven signal, set the threshold of the CTi LT pyrometer to a very high value that can never be triggered.

4.1.4 Heating elements



Picture 13:
Heating
elements.

Install the two heating elements as aiming helpers between the rollers, below the glass sheets. They serve as thermal reference points for positioning the line-scan measurement line in the software and are required for alignment purposes only.

This step may be omitted if the rollers are clearly visible in the thermal image. The operator may decide whether the heating elements remain installed during normal operation.

4.1.5 Remote Control Unit



Picture 14:
Remote
Control Unit

If purchased with the system, install the remote-control unit in a protected location that remains easily accessible to the operator. It can be used to reopen the shutter after an emergency closure or during installation and maintenance work.

The remote-control unit is not required during normal operation, as shutter control is automated by either the CTi LT trigger signal or the oven-door signal.

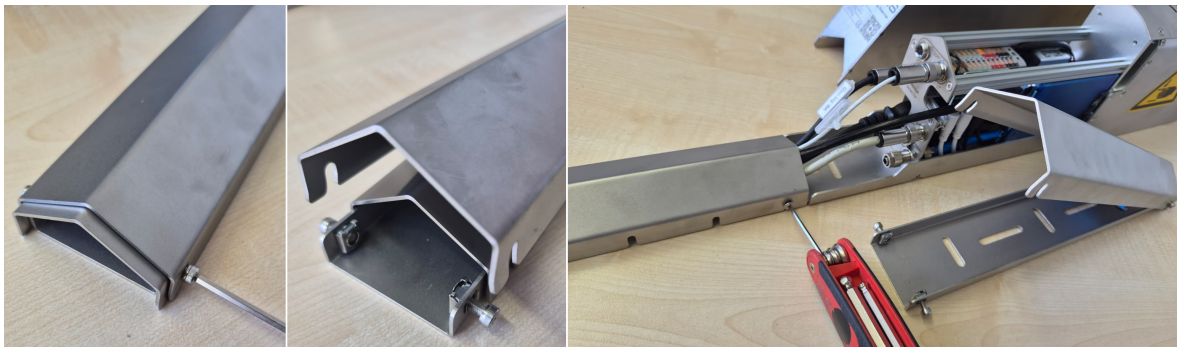
4.1.6 Cable protection

To protect the cables from damage caused by hot falling glass fragments, the supplied cable protection conduit must be installed. The conduit consists of individual units, allowing the overall length to be adjusted as required. The following section describes the mounting procedure.

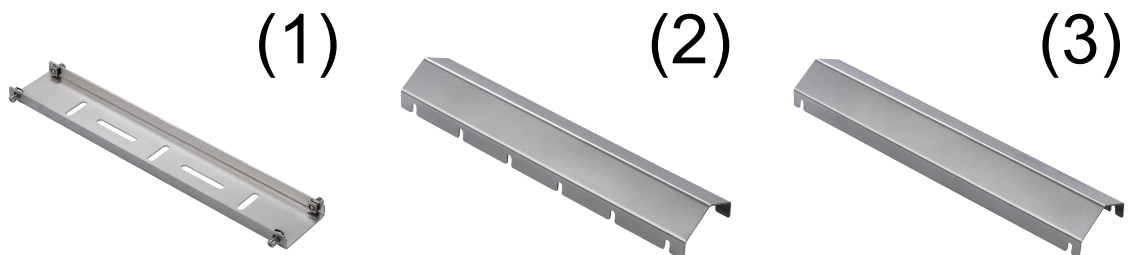
a) Loosen the screws, do not fully remove. Disassemble the rail element consisting of 3 parts.



Picture 15:
Cable pro-
tection unit.



Picture 16: First loosen the screws, then open the cable protection element.



Picture 17: The three parts of one cable protection element.

b) Attach part (2) from the top to GTS main unit (see picture above). Use the appropriate hole to adjust the overall length of the system as required.

- c) Connect the next rail part (3), fasten it to the floor and mount part (1).
- d) Continue installing the conduit until all cables are protected in areas where hot glass pieces may fall.
- e) Adjust the overall length as required. Cover it with part (1).
- f) Tighten the screws securely. Tightening on one side is sufficient if the other side is not accessible.



Picture 18: How to connect the cable protection.

4.2 Software

This section describes the software setup required for operating the GTS system. First, connect the GTS system to the computer via Ethernet. Then install the following software components: PIX Connect, CompactPlus Connect, WuTility, and USB Redirector. All required software is available for download from the Optris website. A detailed description can be found in the following sections.

4.2.1 Installation

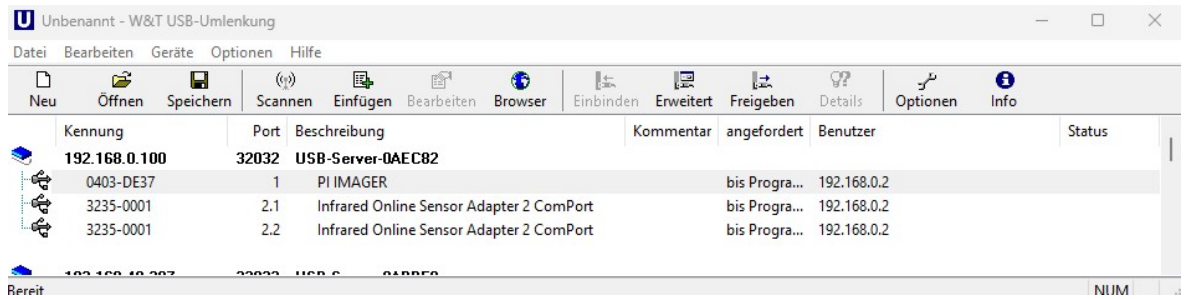
Download **PIX Connect** and **CompactPlus Connect** from our website. If already installed, ensure you are using the most recent version.

Ensure that PIX Connect, CompactPlus Connect and the USB Server Software “USB Redirector” and “WuTility” are installed on your computer. USB Redirector and WuTility are part of the PIX Connect Download file and the manual can be found [here](#).

Connect the system to the network. Ensure that all network settings are set properly:

- Internet Protocol Version 4 (TCP/IPv4)
- IP address camera: 192.168.0.101
- IP address PC: 192.168.0.100
- Subnet mask: 255.255.255.0
- Port Number: 50101

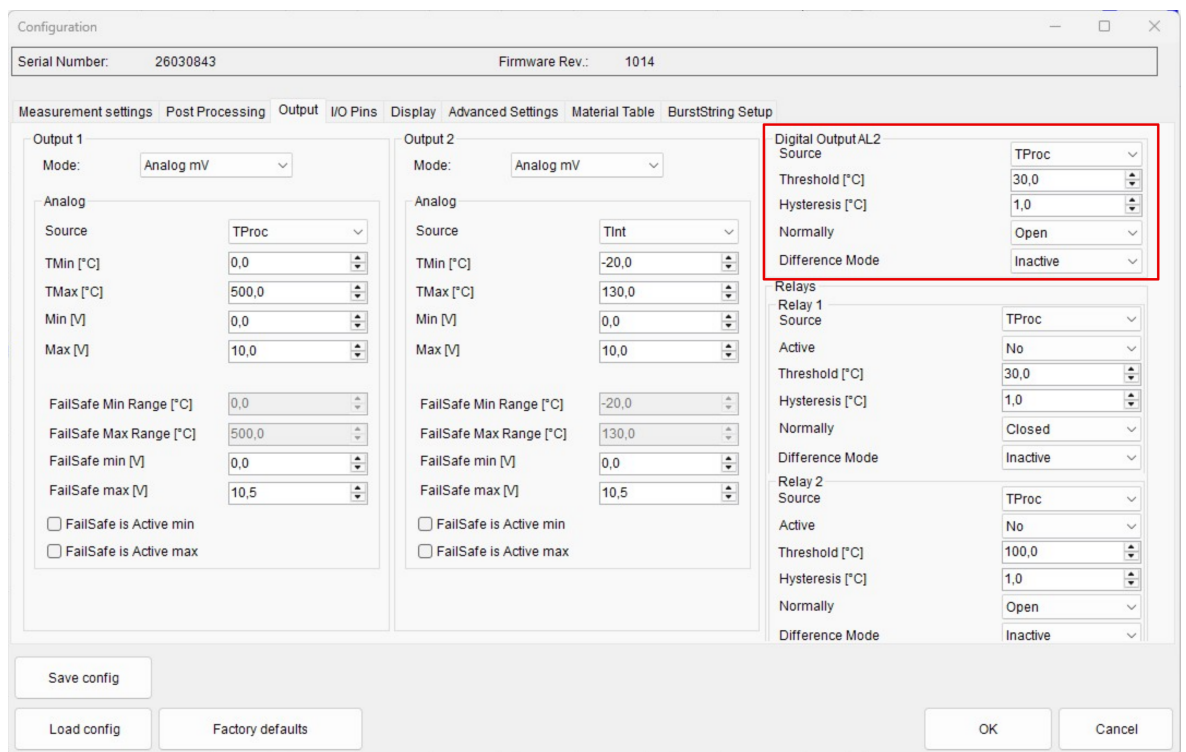
Finally, ensure that all three IR measurement components are permanently connected via W&T USB Utility Software.



4.2.2 Threshold Settings in CompactPlus Connect

The threshold settings for both pyrometers are required to reliably detect when the oven opens and closes and to ensure proper operation of the shutter's emergency closing function.

Open the latest version of CompactPlus Connect to set the threshold for CTlaser and CTi pyrometers. Select the threshold under Configuration → Output → Digital Output AL2 and set the threshold to the desired value.



Picture 19: Threshold configuration via Digital Output AL2 via CompactPlus Connect.

Recommended temperature values provided in this document are intended as general guidelines for operation. It is important to note that different temperature settings may be required during installation and commissioning phases. Furthermore, optimal temperature ranges can vary significantly depending on the specific oven type, process conditions, and application requirements. Therefore, all values should be validated and, if necessary, adjusted based on real operating conditions to ensure accurate measurement and reliable process control.

Pyrometer	Function	Recommended threshold
CTlaser 4M	Glass breakage sensor	80 - 100 °C
CTi LT	Furnace Door Sensor	400 °C (depending on application)

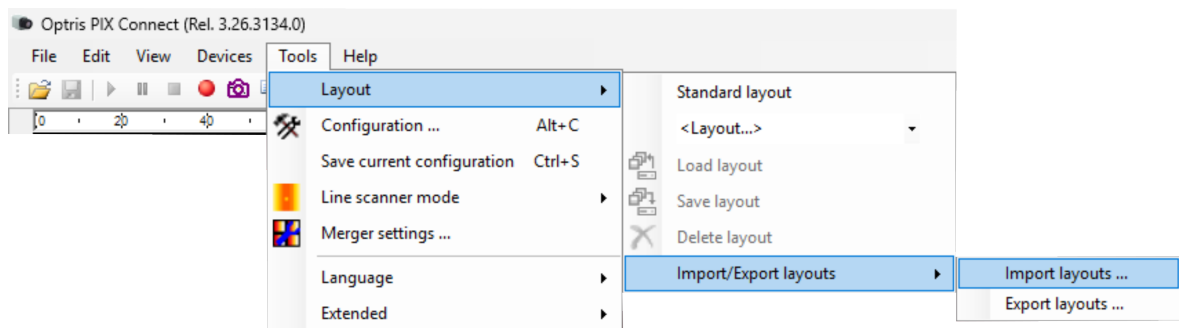
Table 4: Threshold settings

The shutters operate in **Fast Mode**, with a closing time of approximately 100 ms. This rapid response helps prevent broken glass from damaging the camera lens. The system can also provide an output signal indicating glass breakage.

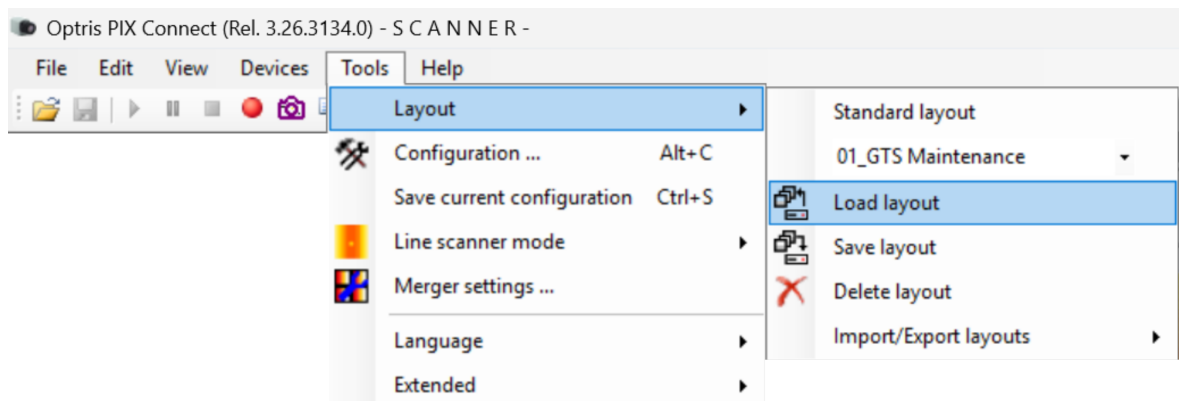
The alarm threshold for the trigger signal is factory-set to 80 °C. This value can be adjusted using the supplied CompactPlus Connect software under **Device > Device Setup**. To prevent accidental triggering, a value of 200 °C and above has been found advantageous in previous installations.

4.2.3 PIX Connect Setup

1. Open the PIX Connect Software. Ensure you are using version 3.26.3135.x or higher.
2. Preconfigured layouts are available for download on our [website](#). There are two versions available: 01_GTS Maintenance.xml and 02_GTS Operation.xml, which can be used for setup and operation, respectively. Import and load them into PIX Connect software to use these layouts.

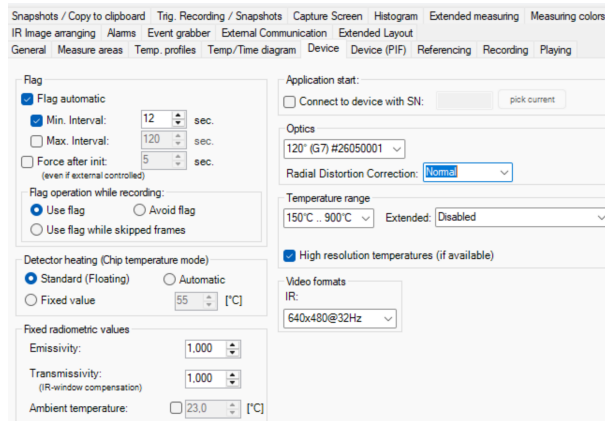


Picture 20: Import layout to PIX Connect.



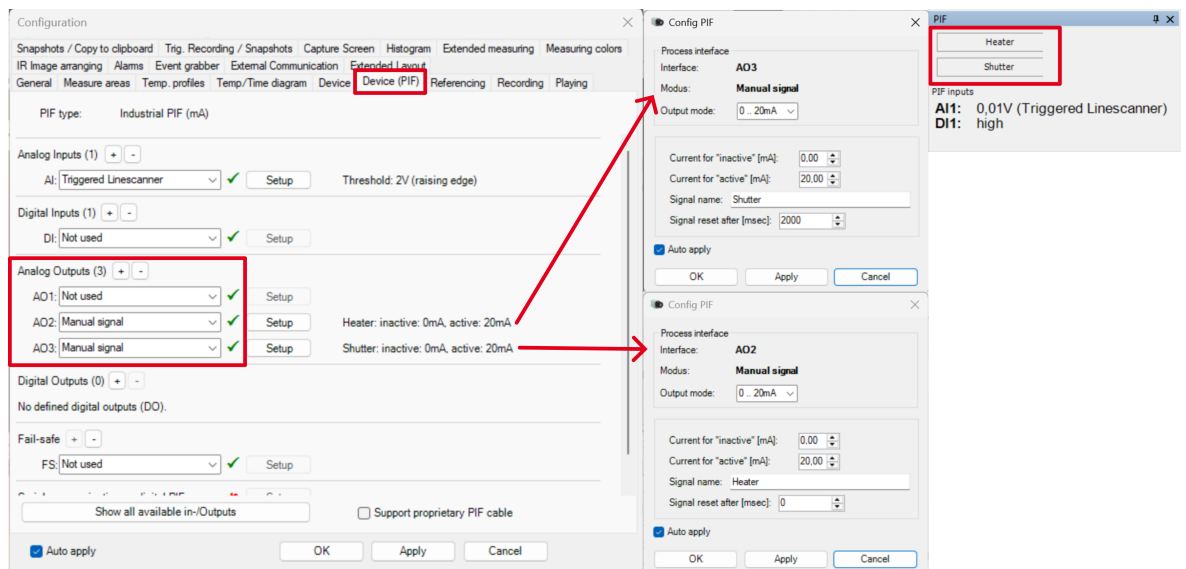
Picture 21: Load layout into PIX Connect.

3. Ensure that you select the subframe rate of 125 Hz for smooth operation.
4. Select the low temperature range for installation. Please note that the 0–250 °C range is intended for sighting and installation only. Accurate temperature measurements are available only above the specified lower limit of 200 °C after the appropriate measurement temperature range has been selected.
5. Ensure that distortion correction is enabled. Go to Settings, Device, and Optics. Select the appropriate option from the drop-down menu.



Picture 22: Enable Radial Distortion Correction, set to normal for horizontal line scanning, and to wide for diagonal line scanning.

- Configure "Heater" and "Shutter" as analog outputs 2 and 3, and display a button. Go to Configuration, Device (PIF) and click Setup for Analog Output 2 and 3. The buttons can be used for switching the heating elements on and off, and opening and closing the shutter. The heating elements should be mounted between the rollers of the furnace and are off by default. They must be activated via analog output.



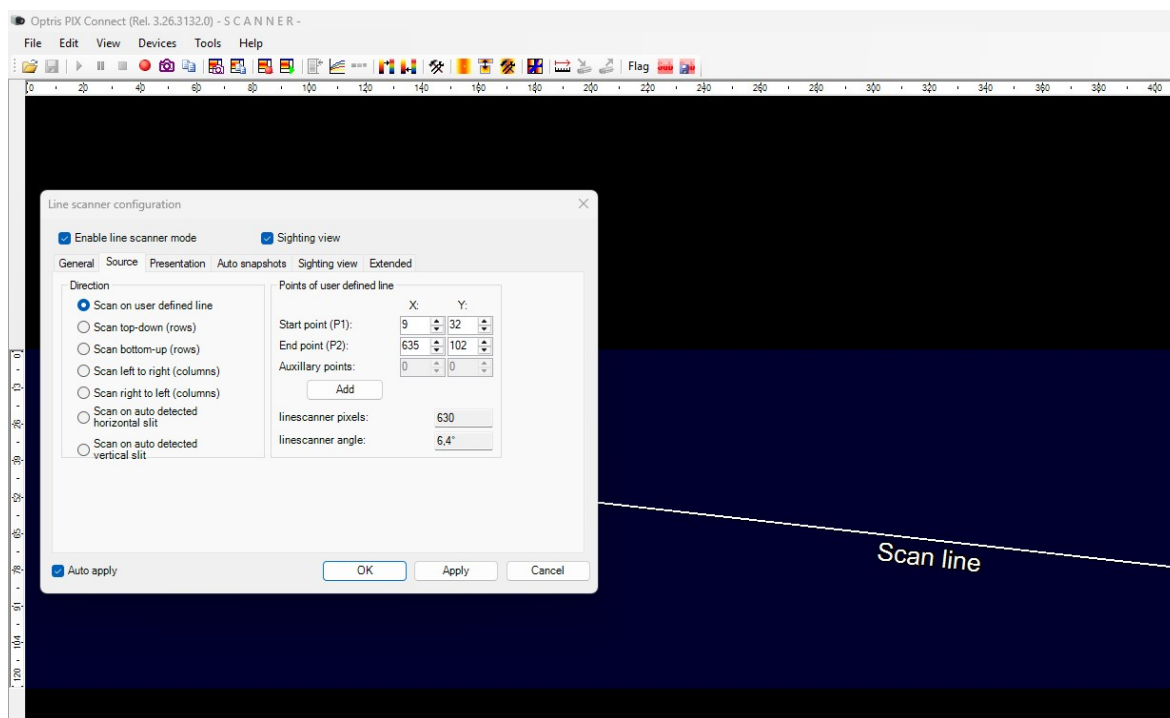
Picture 23: Configure Heater and Shutter via analog outputs.

- Open line scanner configuration.

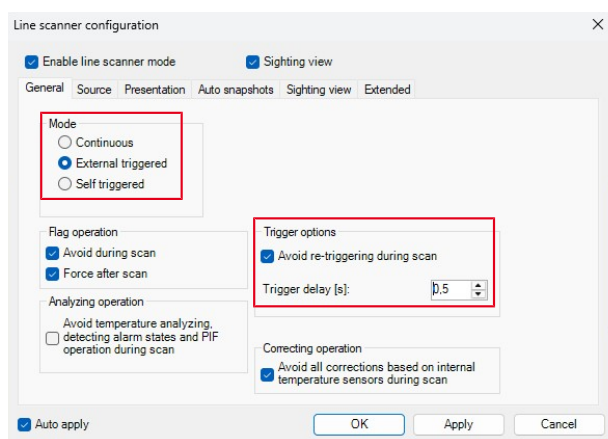


Picture 24: PIX Connect menu, find line scanner configuration icons here: (1) enable line scanning, (2) change between line scanner view and sighting view, and (3) line scanner configuration.

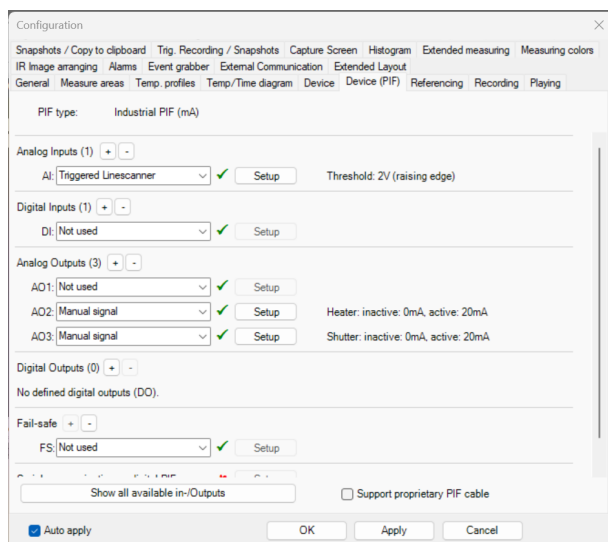
- Click the "Heater" button to turn the heaters on. Position the line so that it passes through the heater points in configuration menu (3). Turn heaters off when this step is done.



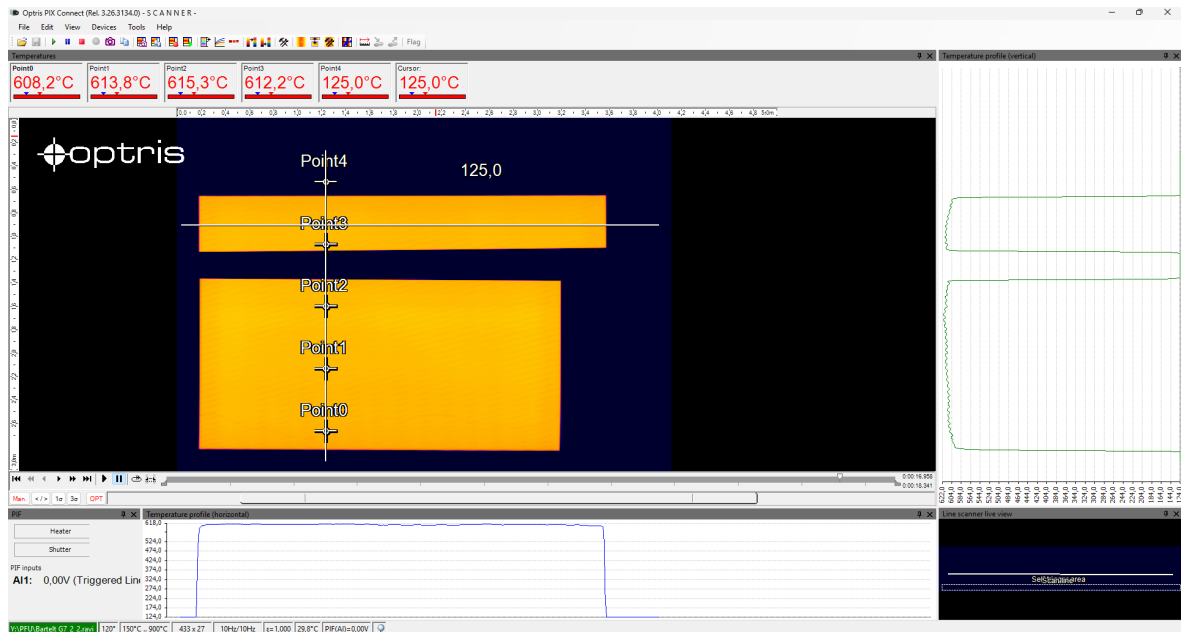
9. Configure the CTi LT trigger to detect the opening of the furnace door and initiate the shutter to open, and the line scanner to start. Set the analog input to triggered linescanner.



10. Set linescan to be triggered externally. Configure an opening delay to ensure that the shutter does not open prematurely.



11. Start the linescanner. Configure your display with all information needed.



12. Remember to store your layout.

13. Check the threshold settings of the CTlaser in CompactPlus Connect before initial start to ensure emergency closure.

14. Select the measurement temperature range for operation.

4.3 Checklists

Please consider this list as a guideline before moving the system to a location that is difficult to access:

1. Verify that all components are connected correctly.
2. Connect GTS system to your computer via Ethernet.
3. Open PIX Connect and ensure access to camera and proper connection to CTi LT and CTlaser 4M.
4. Distortion correction is activated, and set to "normal" for horizontal line scanning and "wide" for diagonal. See PIX Connect Configuration under Setup / Device / Optics.
5. Ensure that the focus of the camera is set correctly. Ensure that shutter cannot close while the lens is being adjusted. Risk of injury!

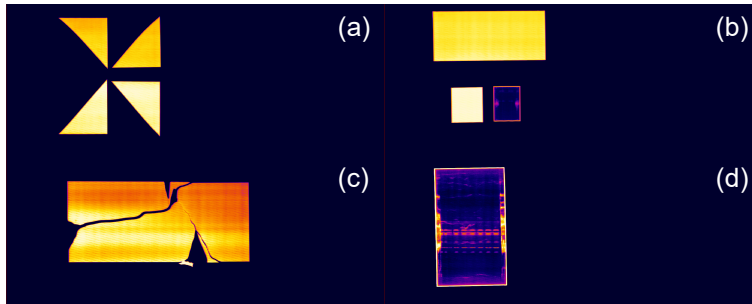
Before starting operation, please verify the following:

1. All parts, including sensors and heaters, are tightly attached to a fixed, non-moving surface. Use mounting holes and provided mounting brackets.
2. Threshold values for CTi LT and CTlaser 4M are set correctly for operation (and not for installation).
3. Test the emergency shutter closure under controlled operating conditions.
4. Ensure that system does not overheat beneath the furnace. Consider attaching air purge to cool USB server.
5. All cables are carefully covered by supplied rails system and cannot be damaged by falling glass pieces.

5 Operation

After the hardware and software installation have been completed successfully, the system operates autonomously using the predefined configuration and signals from the furnace control system.

The operating sequence is as follows: When the GTS system receives the start signal from the furnace, the shutter opens and the measurement process begins. The software starts line scanning at 125 Hz and generates the thermal image line by line. At the end of the scan, a complete thermal image of the glass sheet is created and can automatically be saved as a snapshot (see section **Enable snapshot after every linescan** [► 25]). As each pixel contains a temperature value, the recorded image can be evaluated in detail at any time.



Picture 25: Examples of recorded snapshots of various glass samples: (a) standard measurement of multiple glass samples, (b) three samples with one low-E glass piece, bottom right, (c) broken glass sheet, and (d) low-E glass piece with reflections from the surrounding.

5.1 Optional features

5.1.1 Rectification of IR image

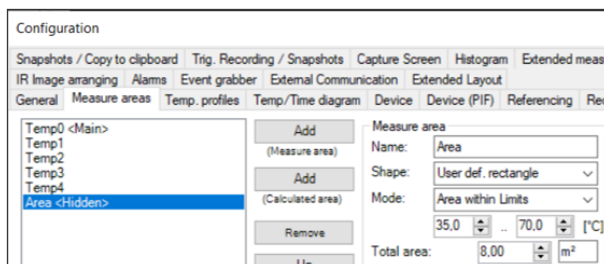
The line-scan image is displayed using metric dimensions that correspond to the actual furnace dimensions. Therefore, the furnace width and length must be entered in the software.

Go to **Tools > Line Scanner Mode > Line Scanner Settings**. In the window that opens, select the **Presentation** tab and enter the required parameters, see **PIX Connect Setup** [► 20].

Enter the furnace width under **Width (Length of Line)** and the furnace length under **Length (of Scan)**. To obtain an undistorted image of the product after the line scan, also enter the furnace **Feed Rate**. Then click **OK** to apply the settings.

5.1.2 Calculation of produced glass area

PIX Connect can calculate the total glass area produced during a single scan pass. To configure this function, select **Tools > Configuration** from the menu. Open the **Measuring Areas** tab, select the measuring area named **Area**, and enter the required value under **Total Area** on the right-hand side.



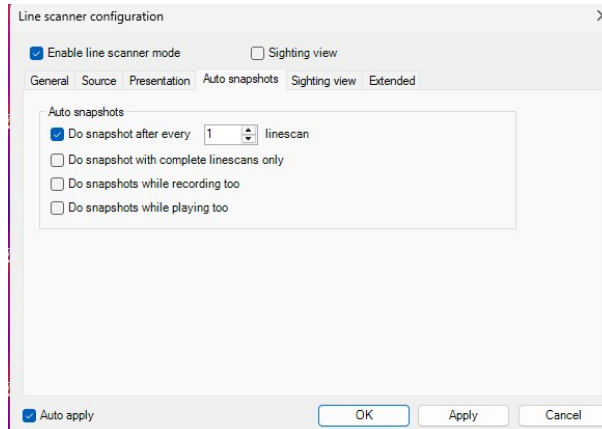
5.1.3 Enable snapshot after every linescan

In the line scanner configuration, it is possible to automatically store the recorded image after every line scan. Enable under linescanner configuration (3):



Picture 26: Legend of icons in PIX Connect.

Open menu, and select Auto snapshots.

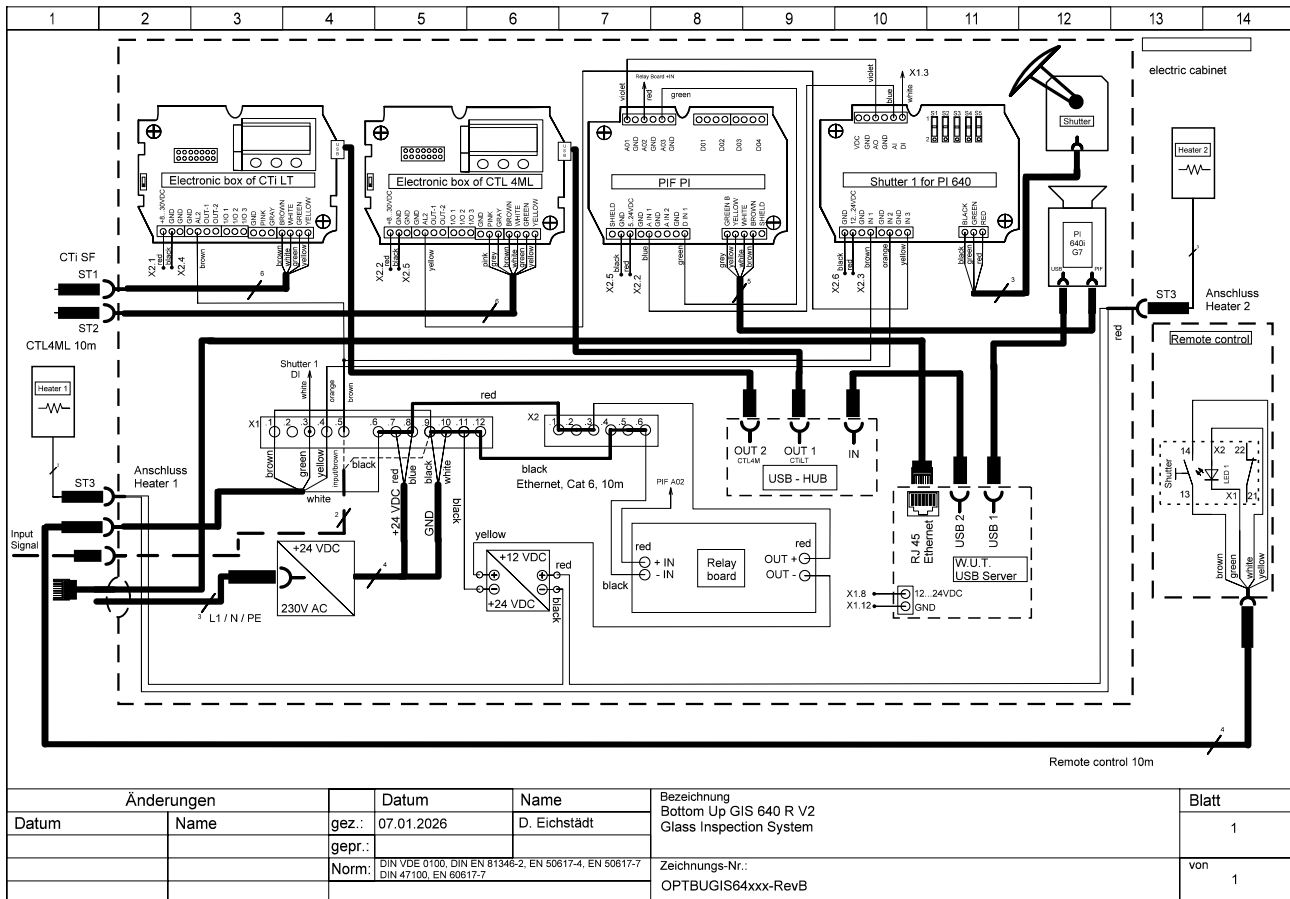


Picture 27: Enable auto snapshots in line scanner configuration.

6 Control Cabinet

This section is for maintenance purposes only, and is typically not required for normal daily operation.

6.1 Electrical Wiring Diagram



7 Basics of Glass Measurement

In general, non-contact infrared temperature measurement is highly suitable for glass applications. However, the following factors must be considered to achieve reliable and accurate measurement results:

- Viewing angle
- Emissivity
- Surface coatings
- Correct sensor and wavelength selection
- Ambient heat and dust conditions

In addition, the penetration depth of the infrared radiation depends on the selected wavelength range:

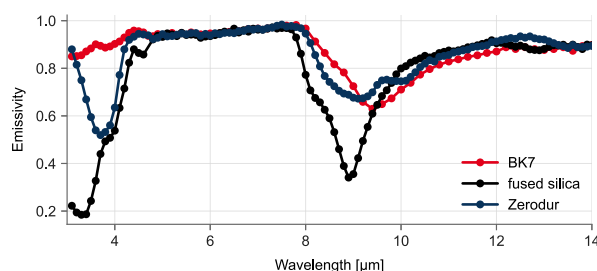
- 1.0 to 3.9 μm : measurement of deeper glass layers
- 5.0 μm and 7.9 μm : surface temperature measurement

7.1 Reflection and Transmission

Reflection and transmission effects must be considered for reliable infrared temperature measurement on glass.

- For long-wave devices operating in the 8–14 μm spectral range (LT), the emissivity ϵ of glass is typically approximately 0.85. In this wavelength range, reflections from the surroundings are comparatively high, especially when measuring coated glass surfaces. Coatings can cause unpredictable changes in emissivity and reflection behavior, meaning that reliable temperature measurement cannot always be guaranteed.
- For devices operating at 5.0 μm (G5) or 7.9 μm (G7), the emissivity ϵ is typically greater than 0.90, while the angular dependence of the reflectivity ρ is significantly lower. These wavelength ranges were specifically selected for glass measurement applications because they provide the lowest influence from surrounding reflections and the lowest angular dependence, which is particularly important when using wide-angle optics such as 120° lenses.

For this reason, G5 and G7 glass sensors are especially suitable for accurate temperature measurement on coated and uncoated glass surfaces in tempering and processing applications.



Picture 28: Emissivity of different glass types.

The figure illustrates the emissivity behavior of different glass types as a function of wavelength. High and stable emissivity values are achieved in the wavelength ranges around 5.0 μm and 7.9 μm , making these ranges particularly suitable and preferred for reliable infrared temperature measurement on glass.

7.2 Influence of Different Detection Wavelengths

The following table provides an overview of the recommended wavelengths and corresponding sensors for different applications. The appropriate sensor selection depends on several factors, including the material, the temperature range, and the surface coating properties.

Spectral Range	Sensors	Applications
8 - 14 μm	PI 640i, Xi 400, CTi LT	Low temperature glass
7.9 μm	PI 640i G7, CTlaser G7, CTi G7	High temperature glass, float glass, glass hardening
5.0 μm	CTi G5, CTlaser G5	
1.0 μm	CTi 1M, PI 1M	Molten glass, container glass, measurement inside material

7.3 Glass Hardening and Temperature Monitoring

Glass tempering, also referred to as glass hardening, is a thermal process in which glass sheets are heated to temperatures typically above 600 °C and subsequently cooled rapidly in the quenching zone. The temperature distribution during both the heating and cooling phases has a direct influence on the final glass quality and the mechanical properties of the product.

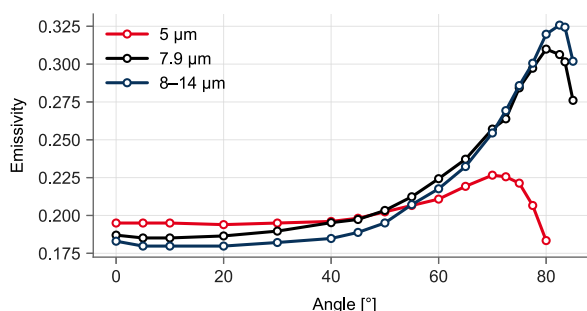
An inhomogeneous temperature profile can lead to defects such as optical distortions, anisotropies, local stress variations, roller waves, or even glass breakage. For this reason, continuous monitoring of the glass temperature distribution is an important part of modern tempering processes.

The Optris Glass Tempering Scanner uses the line scan function of the PI thermal imaging camera to generate a complete thermal image of the moving glass sheet. The system is installed below the furnace and measures the normally uncoated underside of the glass. In most glass tempering applications, the upper side of the glass is coated. These coatings influence emissivity and significantly increase reflections from heaters, furnace walls, and surrounding hot objects, making reliable temperature measurement from above more difficult. Measuring from below therefore provides more stable and reliable measurement conditions by observing the uncoated glass surface.

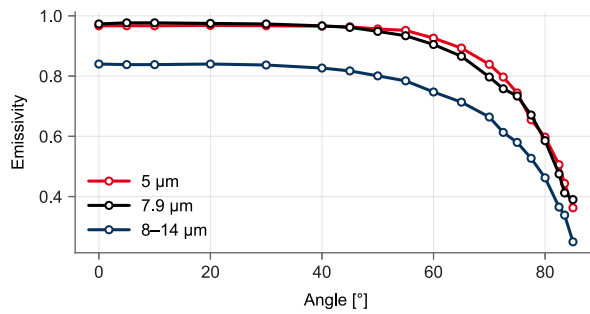
During production, the line scan function continuously transforms the individual image line into a complete thermal map of the glass sheet. This allows visualization of the heating profile and temperature distribution across the entire surface.

7.4 Angle Dependency

The angular dependence of the emissivity is another important factor that must be considered for accurate temperature measurement on glass.



Picture 29: Angle dependence of emissivity at 250 °C for different wavelengths of coated side of low-E glass.



Picture 30: Angle dependence of emissivity at 250 °C for different wavelengths of uncoated side of low-E glass.

On the uncoated side of the glass, the emissivity remains relatively stable up to viewing angles of approximately 45°. On coated Low-E glass surfaces, however, the emissivity changes significantly with increasing viewing angle. For this reason, optics with a 60° field of view are generally preferred for measurements on coated glass, as the influence of emissivity variation remains comparatively low within this angular range.

When using ultra-wide-angle optics such as 120° lenses, the influence of the viewing angle becomes significantly more pronounced toward the edges of the image. In these outer image areas, the emissivity variation can no longer be neglected and may lead to noticeable temperature deviations, especially on coated glass surfaces.

The above figures illustrate the emissivity as a function of the viewing angle for G5, G7, and LT wavelength ranges on Low-E glass at 250 °C. Separate diagrams are shown for coated and uncoated glass surfaces.



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