ContourGT-K

Optical Profiler

User Manual

Innovation with Integrity

Stylus and Optical Metrology

ContourGT-K User Manual

Original Instructions
Bruker Nano, Inc.

October 11, 2012

Manufacturer Information

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About this Manual

This manual provides instructions on the basic operation of your ContourGT-K series optical profiler. It is intended to augment the extensive on-line help provided by the Vision64 software that is used to control the system.

Installation, maintenance and information can be found in the “ContourGT-K Installation and Maintenance Manual”.

General Conventions

Your system hardware operates with the Vision64 software application under Windows 7. You can also run Vision64 independent of instrument hardware under Windows 7.

The Mouse

You can perform three basic actions with the buttons on your mouse: clicking, double-clicking, and dragging. To click, press and release the mouse button. To double-click, press and release the mouse button twice in rapid succession. To drag, press and hold down the mouse button while you move the mouse across your desktop.

Menus

Menus are listings of commands or functions that are available to you at certain times. To open a menu, position the mouse pointer over a menu bar title and click on it with the mouse. A menu pops down from the menu bar. You can then select a command from the pop-down menu by clicking on it.

In this manual, the commands you select from pop-down menus are displayed in the following format: **Hardware** ≫ **Measurement Options**. The double arrow symbol ≫ indicates menu flow as it cascades down from the menu title.

Shortcut Menus

Shortcut menus are available by clicking with the right mouse button on a plot. You can then select options from the shortcut menu that appears.

Typeface Conventions

This manual uses typeface conventions that provide visual cues to help you more easily locate and identify information.

boldface	Menu titles, commands, icons, check box and button names are shown in boldface type.
italic type	Italic type indicates emphasis.
`monospace type`	Code examples, commands and file or directory paths that you must type exactly as they appear are shown in monospaced type.
Small Capitals	Hardware placards and keyboard key labels are shown in Small Capitals for example, Esc, Enter, Alt.
Blue	Hyperlinks within this document.
Magenta	Hyperlinks to websites.

WARNING

A '**WARNING**' is used to emphasize any possibility of personal injury or equipment damage.

Caution

A '**Caution**' is used to emphasize that a possibility of data lost exists, or that you must perform a specific action to ensure proper system operation.

Note A 'Note' contains particularly important information that may aid your understanding of the software, algorithms or system operation instructions.

Contents

List of Figures

List of Tables

1

System Overview

The ContourGT-Ksystems, shown in Figures 1.1 and 1.2, are versatile bench-top optical surface-profiling systems that can measure a wide variety of surfaces and samples, from optical-quality glass to automotive parts. They measure surface topography with high accuracy in a range from fractions of a nm up to approximately 10mm.

Figure 1.1: ContourGT-K(with manual stage)

Figure 1.2: ContourGT-K(with automated stage)

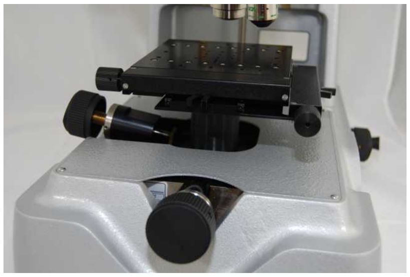
1.1 System Components

The ContourGT-K systems comprise several major components. The most critical part of the system, the Optical Metrology Module (or OMM), is hidden under the system cover; you can find more details about it in the “ContourGT-K Installation and Maintenance Manual”. The parts of the system with which you interact directly and frequently are shown in Figure 1.3.

Sample Stage & Stage Controls are shown in Figure 1.3a. The sample to be measured is placed on the stage. The manual tip/tilt controls are used on all systems. Some systems also use the manual x/y stage shown.

Manual focus knob shown in Figure 1.3b is used to focus manual ContourGT-Ksystems without automated stages.

EMO Box shown in Figure 1.3c is provided with automated ContourGT-Ksystems. It includes an Emergency Motion Off button, power on and off buttons, and a joystick and z-wheel for control of automated stages.



(a) Sample stage & manual stage controls

(b) Manual Focus Knob

(c) EMO Box

(d) Measurement Objectives

(e) Operator Station

(f) Power Supply

Figure 1.3: System Components

Measurement Objectives shown in Figure 1.3d are available in magnifications from 2.5x to 100x and can be mounted on a turret, as shown, or in a single objective adapter.

Operator Station shown in Figure 1.3e is an typical example of the location at which the user interacts with the system.

Power Supply in Figure 1.3f converts AC line voltage to the DC voltages required to run the instrument. The power switch on this power supply is the main on-off switch for the instrument electronics.

1.2 Safety Precautions

Emergency Motion Off Button (EMO)

When the ContourGT system is configured with automated stages it is equipped with an emergency off button, located on the EMO box (see Figure 1.3c). This unit must be placed in any convenient and readily accessible location. Pressing the Emergency Off button, or the power off button, shuts off DC power to the system devices. However, the 24 VDC control circuit remains energized. To re-power the system after an Emergency Shutoff, the EMO button must be released (turn counter-clockwise), then press the green On button.

Equipment Service & Maintenance

Specific risks presented during service or maintenance of this system are described in the "ContourGT-K Installation and Maintenance Manual". Please refer carefully to this manual, and the lockout tagout procedure detailed therein, before undertaking any service or maintenance task.

Residual Risks

ContourGT systems are designed to minimize potential health and safety hazards during normal operation and routine maintenance. However, as with any mechanical system that uses electrical energy and compressed air, it contains some physical and electrical hazards. There are also pinch point hazards from some of the moving parts. You should be aware of these potential hazards and the controls used to minimize them. Customer is advised that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Review this section and contact Bruker if you have any questions on environmental, health, or safety-related issues associated with the system.

Potential safety hazards associated with the system are clearly identified in this manual. In addition, safety labels have been placed on the system where there exists a potential for personal injury or damage to the system. The following table 1.1 illustrates each label and its text message, and indicates where the label is used in the system.

Illustration	**Label Text**	**Where Used**
	ONLY authorized personnel may service this equipment. See manual for safety information.	Interface Box
	Pinch point hazard. Keep hands clear.	Standard manual stage and optional motorized stage: X platform and Y platform

Table 1.1: Labels use to Identify Residual Risks

Electrical Hazards

The system uses electrical power up to 24 VDC and 265 VAC. High voltage or amperage (current) hazards are sufficient to cause death or serious injury to personnel. The primary hazard associated with electricity is electrical shock, which occurs when electrical current flows through part of the human body. Current levels as low as 5 milliamps can cause a painful shock, 10-16 milliamps can cause loss of muscular control (preventing the victim from letting go of the source of shock), and 75 milliamps can cause heart fibrillation (which can be fatal). Therefore, higher voltage circuits pose a greater risk of electrical shock because they have more potential energy to cause an electrical current to flow. However, under the right conditions, even a 30-volt circuit has enough energy to cause 75 milliamps of current to flow through a person's body, possibly causing heart fibrillation that could result in death.

To minimize the risk of electrical shock, the system should be fully de-energized and locked-out when performing maintenance tasks. These tasks may include such activities as replacing fuses or other electrical components. Extreme caution should be used during troubleshooting operations of the electrical system, as live electrical circuits are present. Work with live electrical circuits may include such activities as measuring voltages and current flow during initial set-up or maintenance tasks. Only trained service personnel should perform tasks that require work with live electrical equipment. Factory-authorized personnel should service all internal electrical components of the system.

Other hazards associated with electricity include fire and arcs or flashes. Fires can be started from the overheating of an improperly sized conductor or by electrical arcs or flashes, which occur when an electrical circuit is suddenly short circuited (for example, when a metal screwdriver is accidentally dropped across live electrical terminals). Arcs and flashes generate extreme amounts of heat and can emit molten particles, potentially starting a fire or physically injuring persons in the vicinity. Eye protection should be worn during testing or troubleshooting where live electrical circuits are involved.

Mechanical Hazards

Mechanical hazards exist in the system wherever moving parts are located, such as slides. These moving parts often create pinch points—areas where a person's hand or fingers could get caught or crushed. Moving parts can also create an entanglement hazard if the parts are large enough for part of a person's body to become entangled within them. Pinch-point injuries usually result in a cut or crushed finger or hand, but can result in loss of a finger or hand. Entanglement hazards are usually more serious and more likely to result in loss of a limb, or even death. Protection against mechanical hazards in the ContourGT is provided in the form of physical guards such as the measurement head cover and the system base.

Thermal Hazards

Unlike most other physical hazards, thermal hazards are not eliminated by removing power. Surfaces may remain hot for up to 30 minutes after removing the heat source. Contact with potentially warm or hot surfaces or components, such as lamps, motors, and heat-sinks may cause skin burns. Allow the system to cool to ambient temperatures before attempting to remove/service components.

Pressure Hazards

Pressure hazards exist due to the difference in kinetic energy of a gas within a container or piping system and the surrounding environment. If a sudden breach of a gas line or a pressurized container were to occur (for example, a gas delivery line bursts), the pressure differential between the gas in the line and the surrounding atmosphere will cause the gas to be forcefully expelled into the surrounding atmosphere. This can cause physical injuries due to particles flying outward at extremely high speed.

ContourGT optical profiler systems use compressed clean dry air (CDA) for the vibration isolation system.

The CDA fittings or components of the pneumatic system should be adjusted only after appropriate release of air-line pressure. As with electrical and mechanical tasks, maintenance activities involving the air lines should occur only after appropriate pressure lockout procedures have been implemented.

1.3 Basic Measurement Modes

The ContourGT-K OMM supports Vertical Scanning Interferometry (VSI) and Phase-Shifting Interferometry (PSI) measurements.

VSI Measurement Mode

Vertical scanning interferometry uses a broadband (normally white) light source. It is effective for measuring objects with rough surfaces, as well as those with adjacent pixel-height differences greater than 135 nm. VSI mode yields precision in the nanometer range. In vertical scanning interferometry, the internal translator moves the objective while the camera periodically records frames. As each point on the surface comes into focus, the modulation on that point reaches a maximum, then tapers off as the objective passes through focus. By recording the height of the translator at maximum modulation, the system can determine the height of each pixel. The maximum scan length for a VSI scan is 10 mm.

PSI Measurement Mode

Phase-shifting interferometry uses a narrowband light source. It is typically used to test smooth surfaces (roughness less than 30nm), such as mirrors, optics, or other highly polished samples. It is very accurate, resulting in vertical measurements with sub-nanometer resolution. However, PSI cannot obtain a correct profile for objects that have large step-like height changes. It thus becomes ineffective as height discontinuities of adjacent pixels approach one quarter of the used illumination wavelength (about 135 nm when using green light). In phase-shifting interferometry, the internal translator precisely alters the optical path length of the test beam. Each optical path change causes a shift in the fringe pattern. The shifted fringes are periodically recorded by the camera, producing a series of interferograms. Computerized calculations combine these interferograms to determine the surface height profile.

The Mechanics of Measurement

The OMM includes a camera, LEDs that provide green and/or white illumination, a scanner assembly, and a measurement objective. The “interference” used to calculate the surface height is achieved inside the measurement objective by splitting the light into reference and measurement beams: the reference beam is reflected off a super flat reference mirror inside the objective, while the measurement beam is reflected off the sample. The reference mirror inside the objective is positioned so that it is in the same focal plane as the sample (that is, it is the same distance from the beam splitter as the sample). In this configuration, the two light beams recombine and form an interference pattern of light and dark bands called fringes. The number of fringes and their spacing depends upon the sample shape and the relative tilt between the sample and the reference mirror. If the sample is very flat, the fringes are straight. As the relative tilt between the sample and the reference mirror is reduced, the number of fringes is also reduced until the sample and reference are parallel, and the fringes are said to be nulled.

1.4 Software Control of the ContourGT-K

Vision64 is a state of the art metrology application that runs under Windows 7 64 bit edition. Incorporating the latest computer technology, Vision64 is both powerful and easy to use. With an ergonomic user interface design, using this application is intuitive and efficient. In conjunction with Bruker’s best in class profiler instruments, Vision 64 provides unsurpassed capability for the measurement and characterization of surface topography.

The Vision64 software controls the instrument settings, data analyses, and graphical output. It allows for considerable customization of output display and enables analysis results to be stored to a database. Measurement and analysis settings can be saved in configuration files for use in future measurements. A shortcut to this program can normally be found on the task bar as shown in Figure 1.4. A single click of the task-bar shortcut runs the application.

Figure 1.4: Windows task-bar showing **Start** button and 'pinned' Vision64 Shortcut

Important Directories

The Vision64 application directory, `C:\Program Files\Bruker\Vision`, holds the Vision64 executable code. `Vision64.exe` is the application that runs the instrument.

The directory `C:\ProgramData\Bruker\Vision` and it's sub-directories hold data and configuration information for the application.

The Vision64 Workspace

The Vision64 application window is divided into several distinct functional areas/panels as shown in Figure 1.5 and described below. Figure 1.6 shows how the actual application appears on screen.

<table>
<tr><td rowspan="2">App. Menu Button</td><td colspan="2">Quick Access Toolbar</td></tr>
<tr><td colspan="2">Ribbon Tabs</td></tr>
<tr><td colspan="3">Ribbon</td></tr>
<tr><td colspan="2">Display Tabs</td><td rowspan="2">Measurement Control Panel</td></tr>
<tr><td colspan="2" rowspan="2">Main Display Area</td></tr>
<tr><td rowspan="2">Data Analyzer</td></tr>
<tr><td colspan="2">Active Data Gallery</td></tr>
</table>

Figure 1.5: Vision64 Workspace Layout

Application Menu Button Used to access the common application functions.

Quick Access Toolbar Customizable to access frequently used options.

Ribbon Tabs Clicking these tabs changes the ribbon.

Ribbon The ribbon is a graphical style menu that provides access to all the functions available in the Vision64 software. Note that the most commonly used icons have been made permanent to the the left and right of the ribbon.

Display Tabs These tabs allow selection of the content in the Main Display Area.

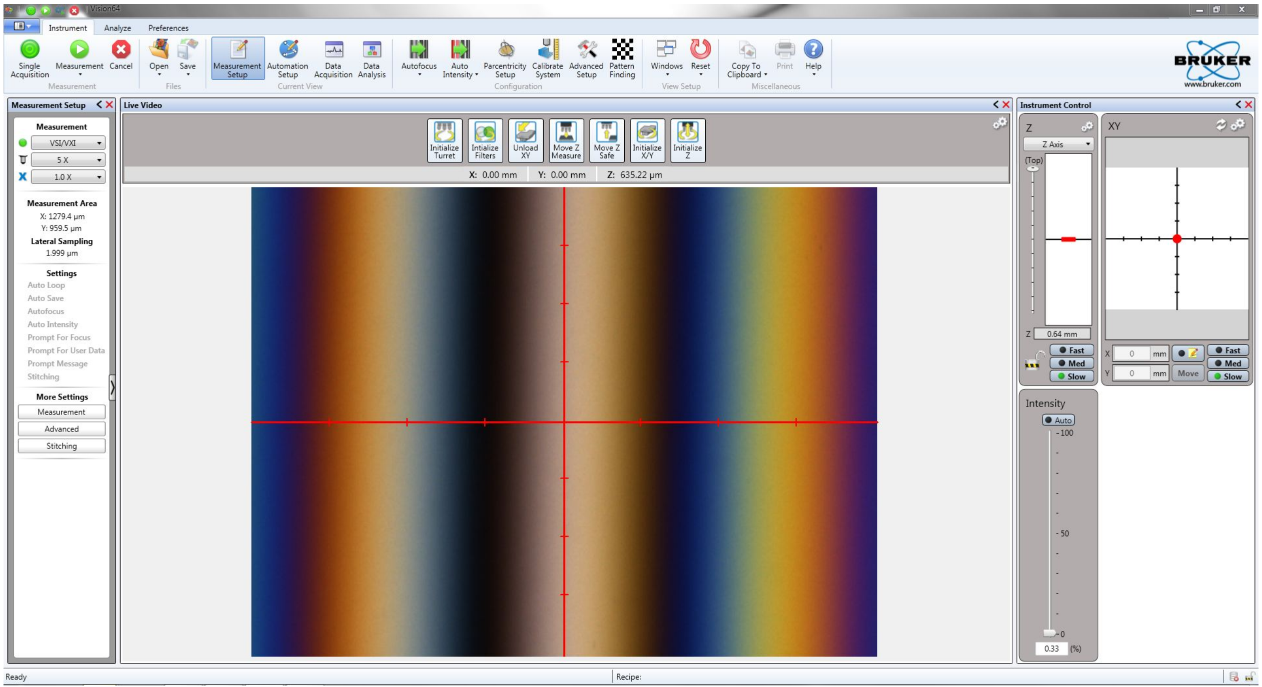


Figure 1.6: Vision64 Workspace Screen Shot

Main Display Area Where Vision64 displays most of it's information. The functionality of this area changes dependent on the tab selection. If a dataset tab is selected, the Data Visualization Manager is invoked to provide multiple representations/visualizations of the dataset. Other windows that can be displayed in this area include the **Live Video** display that is used to control the system and the **Database** display to view analysis results.

Measurement Control Panel Shows the primary settings for the active measurement mode and allows these settings to be changed.

Data Analyzer Shows the filters and analyses applied to the current dataset and allows customization of this data flow in order to extract the key parameters of interest from the dataset. This section is only active when a dataset is displayed.

Active Data Gallery Displays thumbnail images of active datasets. Clicking a dataset's thumbnail selects it for viewing in the main display area.

A note on Split-Buttons

The ribbon contains several split-buttons that have two active areas. Clicking the icon executes the default command for the button. Clicking the arrow accesses a sub-menu with the full list of commands available.

2

Basic Operations

To use your ContourGT-K system you must become familiar with the processes of:

- Turning on and off the system and starting/stopping the Vision64 software.
- Positioning a sample for measurement:
  1. Placing the region of interest within the field of view of the camera.
  2. Adjusting the system focus so that fringes are visible on the sample surface.
  3. Adjusting the relative tilt between the sample and the reference mirror to ensure that fringes are visible.
- Selecting the measurement parameters and making a measurement.

These process are covered in general in this chapter. Chapter 3 demonstrates how to make basic PSI and VSI measurements with this hardware and software. If you are already familiar with optical-surface profilers you may wish to skip directly to Chapter 3.

2.1 Turning On the System & Starting the Vision64 Software

1. Turn on the system power.

All ContourGT-K systems are equipped with a single DC power supply that must be turned on; the manual ContourGT-K systems are equipped with a powersupply as depicted in the top picture and the automated ContourGT-K systems are equipped with the PDU power supply as depicted in the bottom picture. The On/Off switch is located on the back of the powersupply box.

ContourGT-K systems with motorized axes are also equipped with an EMO box. There is an additional Power On button on the EMO box that must be pressed to deliver power to the system. (Note that if the Emergency Off button is depressed, it must first be released.)

2. Turn on and log in to the computer.

3. Click the **Vision64** icon in the taskbar to launch the Vision64 application.

A single click of the **Vision64** shortcut starts the Vision64 application. The shortcut is located next to the **Start** button at the bottom left of the screen on the Windows toolbar.

Note It may take up to a minute for the system to initialize. During this time the Vision64 splash-screen is displayed (see Figure 2.1).

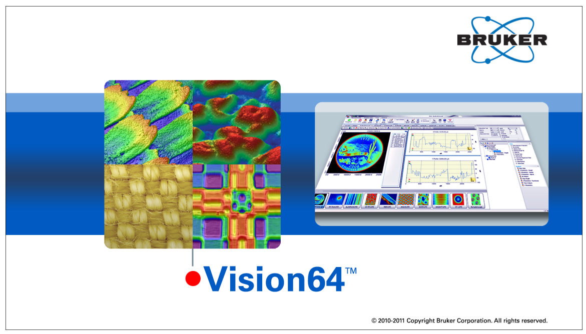


Figure 2.1: Vision64 splash-screen

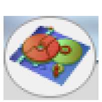
If the ContourGT-K system will not start properly, take these steps before contacting Bruker Customer Service:

1. Verify that all cables are properly connected and free of obvious damage.
2. Verify that the power switch on the front of the computer is in the On position.
3. Verify that the power switch on the power supply is in the On position.
4. Verify that the EMO is not activated, and that the green power button on the EMO box is illuminated.
5. Try again.

2.2 Closing Vision64 & Turning Off the System

To turn off the system:

1. Close Vision64 by clicking the **Vision64** application button followed by **Exit Vision**.

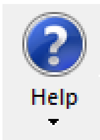


The **Vision64** application button appears at the top left of the application window. This button accesses the traditional **File** menu.

2. Close Windows by clicking **Start** followed by **Shutdown**.
3. Turn off the system power (at the EMO box and/or at the power supply).

2.3 Using Vision64's On-line Help

On-line instructions for the use of the Vision64 software are immediately available through the Help menu. To access help click the **Help** button or press the F1 key.



Clicking the top portion of the **Help** button opens the help application within the **Main Display Area**.

You can click into another **Display Tab** to change the contents of the **Main Display Area** then return to the same help page by re-selecting the help tab. The help opens to a table of contents (on the left) and an introduction to Vision64. Help topics can be selected:

- from the tree view of contents.
- by clicking **Index** (at the bottom left of the help tab) and scrolling through the index on the left side of the tab.
- by clicking **Search** (at the bottom left of the help tab) and inputing a search term in the search box.

2.4 Using the Live Video tab

Before taking a measurement, the sample must be positioned and the system setup to:

1. Place the region of interest within the field of view of the camera.
2. Set an appropriate illumination level.
3. Adjust the system focus so that fringes are visible on the sample surface.
4. Adjust the relative tilt between the sample and the reference mirror to ensure that fringes are visible.

Most of these actions are achieved while looking at and adjusting the settings via the **Live Video** tab (you may need to click **Live Video** tab to make it active in the **Main Display Area**). It displays a live view of the measurement area and provides access stage and illumination controls. Figure 2.2 shows the typical appearance of this window.

Note Only available motorized axes are displayed in the **Live Video** tab.

Sample View

On the left of the **Live Video** tab a live image of the sample is always visible. Changes to the sample position and the illumination conditions are shown here. Note that the ContourGT-K family of optical surface-profilers use monochrome video cameras so the image is always gray-scale. When the ContourGT system is configured with automated stages, it will display the current stage positions at the top left of the image.

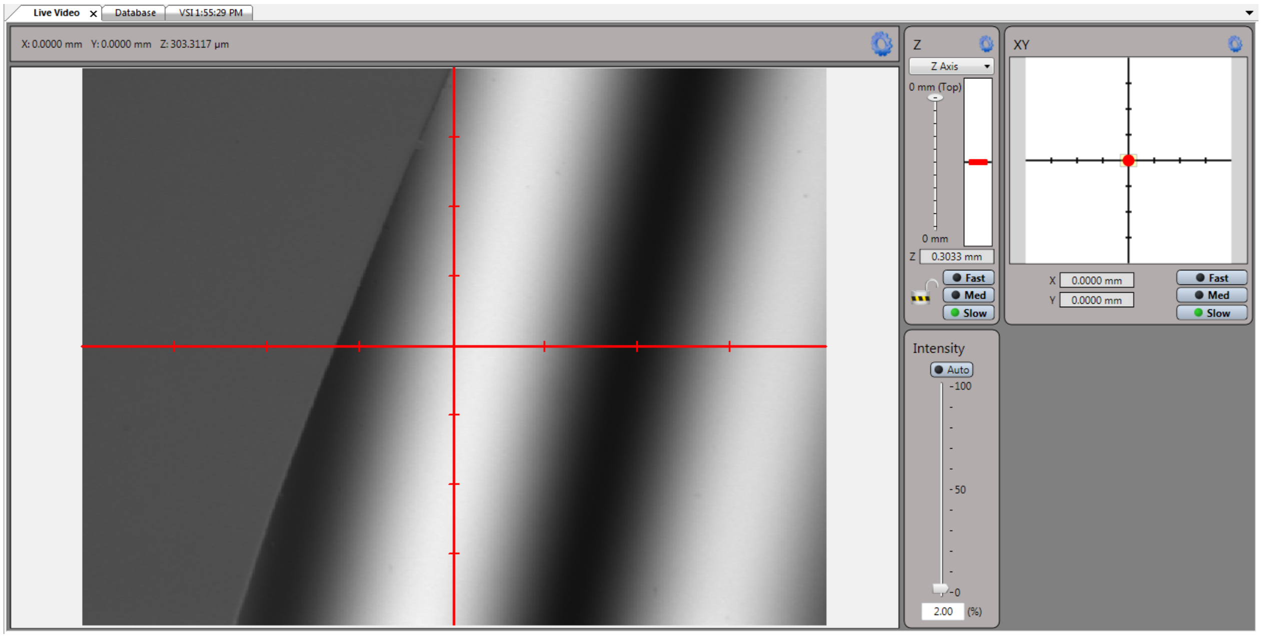


Figure 2.2: **Live Video** tab active in the **Main Display Area**

Controls

Z-axis, intensity, tip/tilt and x/y stage position controls are located on the right side of the **Live Video**. If a particular function is not available then its control is not shown. The use of these controls is described in greater detail in further sections of this chapter.

2.5 Illumination Control

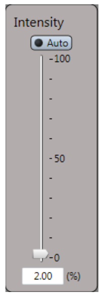
The intensity level of the ContourGT-K is adjusted via the **Intensity** control of the **Live Video** tab; See Figure 2.3a.

You adjust the intensity by:

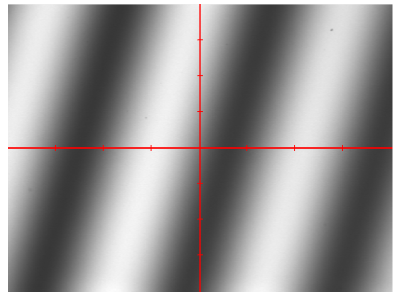
- Clicking the control bar and 'sliding' it up or down.
- Clicking **Auto** atop the slider bar.

Ideally the intensity should be set to just below the point at which saturation occurs. An example of ideal illumination is shown in Figure 2.3b. When there's too much light the image becomes saturated and red pixels are displayed. Illumination that's too low or two high will cause measurement problems. Examples of non-optimal illumination levels are shown in Figures 2.3c and 2.3d.

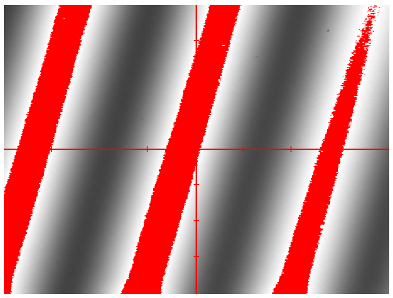
When you select **Auto** the illumination level is automatically adjusted to just below 'saturation' and maintained at that optimum level, even as you adjust focus and/or move the sample. The indicator 'light' to the left of **Auto** is green when the auto mode is active.



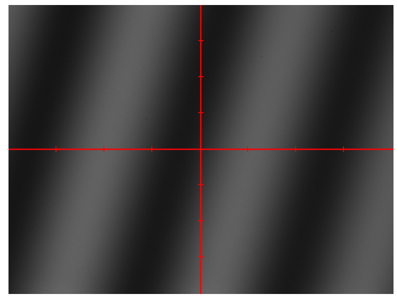
(a) Intensity Control Bar



(b) Optimum



(c) Too high



(d) Too low

Figure 2.3: Intensity Control

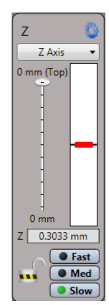
2.6 Adjusting Focus

Using the Z-axis

You can measure samples of many different sizes by raising or lowering the z-axis. You adjust the height of a manual z-axis by turning the focus knob on the right side of the instrument (see Figure 2.4a); turn the knob clockwise to raise the z-axis and counter-clockwise to lower it. On a motorized z-axis focus is controlled either via the z-axis wheel (see Figure 2.4b) or through the Vision64 software (see Figure 2.4c). To find fringes on a sample, you must adjust the z-axis to put the sample surface in focus.

(a) Manual focus knob

(b) Motorized z-axis wheel



(c) Vision64 software

Figure 2.4: Focus Adjustment Mechanisms

A high speed focus mode is available on motorized z-axis systems when the Fast button next to the z-axis wheel is pressed. To control the z-axis from the software, click the red center bar and 'pull' it up or down. The software control allows fast, medium and slow focus speeds. Simply click **Fast**, **Med** or **Slow** buttons to select the 'move' speed before initiating the move.

Using the Scanner axis

Focus can also be adjusted by changing the position of the scanner. On a manual z-axis system the z-axis control that appears by default (Figure 2.4c) enables adjustment of the scanner position. This is useful on a manual system because finer control is available via the software than via the manual focus knob. On the automated systems, the scanner position control can be accessed by clicking on the arrow next to **Z-Axis** in Figure 2.4c and selecting **Scanner**.

Note	It's best to use the scanner sparingly for focus duty. If a lot of focusing is performed via the scanner it can be moved towards the end of its travel range and thus limit the effective measurement scan-length.

To Find Focus ***Safely***

The following procedure ensures that the objective is traveling up and away from the sample while you are watching for fringes in the Intensity window. This helps prevent a crash between the objective and the sample. To focus on a sample:

1. Select the **Live Video** tab and click **Auto** on the intensity control.
2. While watching the objective carefully from the side, adjust the focus to lower the OMM so that the objective is a few millimeters above the surface of the sample. You may wish to refer to table 2.1 so you can initially position the objective fairly close the nominal focus position.
3. Focus the system by slowly raising the OMM. As you raise the OMM watch the intensity window:
   a) to see when the sample features start to sharpen.
   b) to see when the intensity value reaches a minimum.
4. When any of the above occur you are very close to focus. Slow your adjustment and watch very carefully for fringes. Note that if the sample is highly tilted the fringes may appear over a very narrow band.
5. Continue to raise the OMM until fringes appear in the Intensity window. If the required intensity starts to increase you have passed through focus and will need to lower the OMM again.

2.7 Adjusting Lateral Sample Position

The ContourGT-K systems come with staging that allows 150 mm (6 inches) of x and y travel. On a manual stage you control x/y movement by turning fine-positioning knobs and sliding coarse-positioning clips (see Figure 2.5a). Pinching the coarse-positioning clip disengages the stage-carriage from the lead screw so that it can be moved into position quickly.

If your stage is motorized the control is achieved either via a joystick (see Figure 2.5b) or through the Vision64 software (see Figure 2.5c).

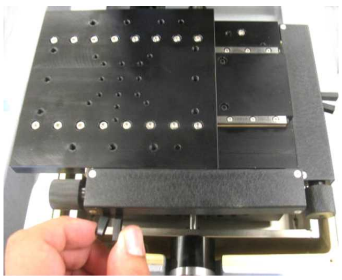
When a joystick is available, the stage can be controlled by the joystick whenever the Vision64 software is running. On the joystick, a fast move is made possible by pressing the button on top of the joystick.

Within the Vision64 software moves are actuated in one of three ways:

1. By 'pulling' the red dot from the center of the grid in the direction you want the stage to move. Note that the further you pull the dot from the center the faster the stage will move. In addition, you can select the nominal move speed by clicking the **Fast**, **Med** or **Slow** buttons before initiating a move.

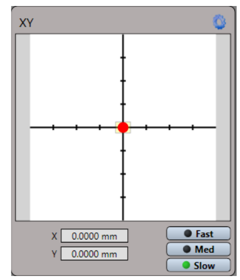
2. You may double-click anywhere in the x/y grid to move the stage directly to that location.

3. You may double-click anywhere in the **Sample View** (see Figure 2.2) to move that point to the center of the cross-hairs.



(a) Manual X/Y adjustment

(b) Joystick for X/Y adjustment



(c) Vision64 software

Figure 2.5: X/Y Adjustment

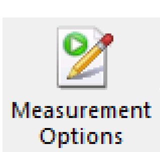
2.8 Adjusting Sample Tip and Tilt

The ContourGT-K systems come with a manual tip-tilt stage that has $\pm 6°$ of tip and tilt adjustment. The stage has two knobs, one on the front of the system and one on the left, as seen in Figure 2.6a. You turn these tip and tilt knobs to finely adjust the fringes until they are of the optimal size and position for your type of sample and measurement. Often this means adjusting the tilt so that between 0 and 15 fringes are visible for a VSI measurement or < 5 fringes for a PSI measurement.

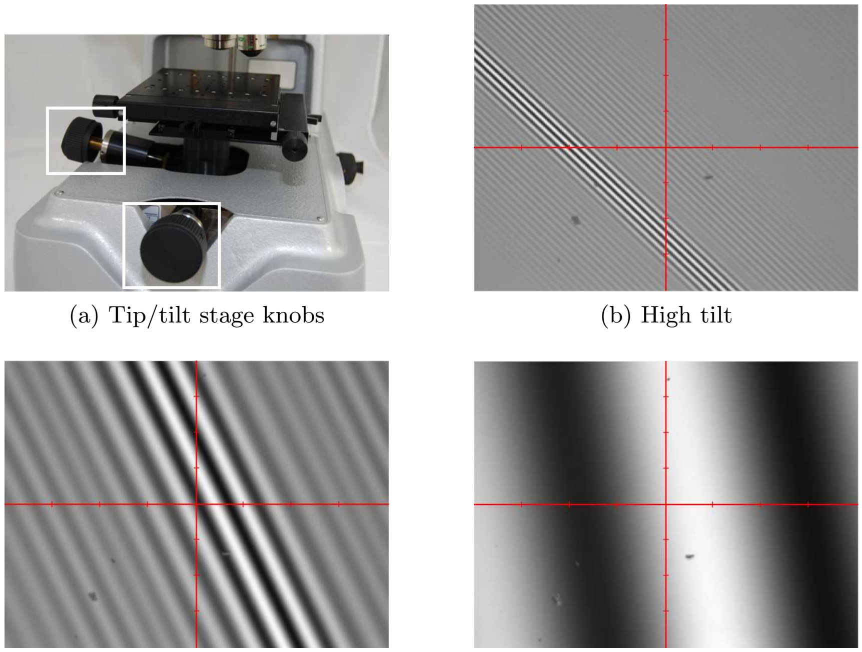
Note The fringes will likely move out of focus when the tip and tilt are adjusted so you will normally need to adjust the focus at the same time as you adjust tip and tilt.

Figure 2.6b shows typical high-tilt fringes that may be visible after finding focus. Figures 2.6c and 2.6d show the result of adjusting the tip tilt knobs so that fewer and fewer fringes are visible.

2.9 Measurement Options



The **Measurement Options** button appears on the Vision64 application ribbon. This button is used to access measurement options and is only visible when the **Measurement Setup** tab is selected.



(a) Tip/tilt stage knobs (b) High tilt

(c) Medium tilt (d) Low tilt

Figure 2.6: Tip/tilt Control & Tilted Fringes

Note When the tilt is extreme the fringes are very close together and hard to find. If you have trouble finding fringes in this circumstance it is often helpful to perform a coarse tilt adjustment by following this procedure:

1. Click the **Auto** button in the intensity control bar (Figure 2.3a).
2. Adjust the tip and tilt while watching the intensity setting. The lowest intensity requirement is normally found when the sample is close to flat.
3. If fringes are not visible, re-adjust the system focus and try again.

Many of the system features are accessed via the **Measurement Options** dialog. This dialog contains two or three tabs but only the functionality of the first, **Measurement Parameters**, is described here. The appearance of this first tab is dependent on the selected measurement type but only the top portion is relevant and it is shown 2.7.

Measurement Type Selection

The desired measurement type is selected from the drop-down list to the right of the **Measurement Type** text in the dialog.

Magnification Selection

On an automated system selection of the desired magnification from within the Vision64 application results in the immediate change of the system optics. On manual systems after selection of the de-

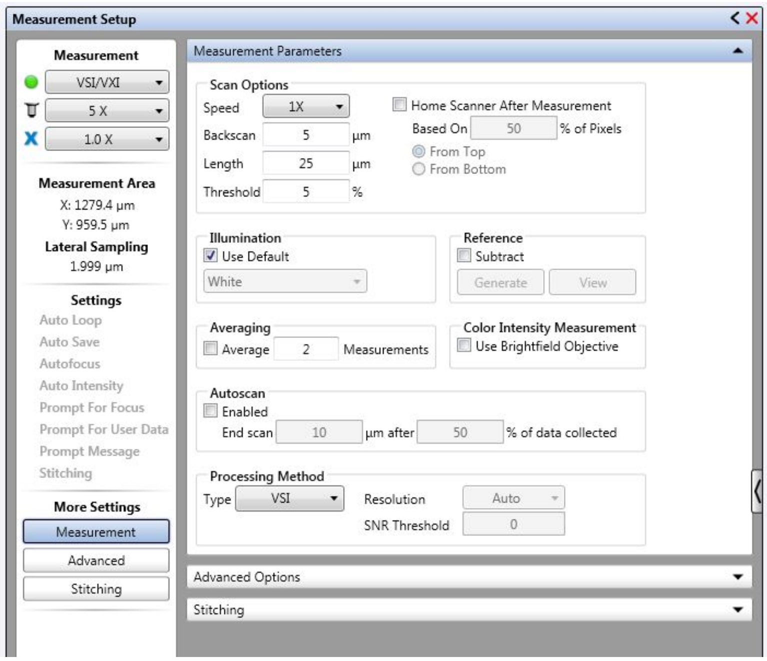


Figure 2.7: **Measurement Parameters** tab of the **Measurement Options** dialog

sired measurement magnifications within the software you must manually change the measurement optics.

Caution

Ensure that sufficient clearance exists between the objectives and the sample to avoid objective–sample contact when a new objective is selected via the software on an automated system.

To change the measurement magnification:

1. Open the **Measurement Options** dialog (Figure 2.7).
2. Change the objective magnification by selecting a new objective from the drop-down list to the right of **Objective**.
3. Change the FOV lens magnification by selecting a new FOV from the drop-down list to the right of **Multiplier**.
4. Note that the approximate measurement area for the selected optics combination is automatically updated in the **Measurement Area** section.

Manual Optics Selection

For an objective change:

- If the objectives are mounted in a turret, grasp the base of the turret and rotate the desired objective into the measurement position (front and center in the turret).

- If a single objective adapter is used refer to the "ContourGT-K Installation and Maintenance Manual" and follow those instructions to change an objective.

For an FOV lens change:

1. Remove the system cover.
2. Remove the installed FOV tube (lift up then out) and put it in a storage container.
3. Insert the desired FOV lens in the OMM (insert laterally, then push down to seat).
4. Replace the system cover.

Caution

On a manual system, if you do not match the software magnification selection with the installed optics, the lateral dimensions of the measurements will be wrong.

2.10 Objectives

Objectives can be mounted to the OMM via a single-objective adapter (see Figure 2.8a) or a turret (see Figure 2.8b). Up to four or five objectives can be mounted on the turret, depending on the model purchased with the system. For instructions on changing objectives, see the "ContourGT-K Installation and Maintenance Manual".

(a) Single Objective Adapters

(b) Turrets

Figure 2.8: Objective Mounting Methods

The working distance of each objective is the distance from the bottom of the objective to the top of the sample when the sample is in focus. By keeping in mind the working distance, you can reduce the possibility of damage to the sample and the objective when you are focusing the system. The working distances for the objectives that can be used with ContourGT-K are listed in Table 2.1.

2.11 Performing a Measurement

If you feel ready, you can make a measurement by clicking the **Measure** button on the ribbon.

Magnification	Interferometer Type	Working Distance (mm)
2.5	Michelson	3.5
5	Michelson	6.7
5XL	Michelson	9.4
10XBF	None	10.6
10X	Mirau	7.4
20X	Mirau	4.7
50X	Mirau	3.4
20XLWD	Michelson	22
5XLWD	Michelson	22
10XLWD	Michelson	22
1.5XL	Michelson	9.6

Table 2.1: Working Distances for Objectives

The **Measure** button is a split-button. Clicking the top half of the button initiates the measurement defined in the currently selected recipe. A click on the arrow provides access to additional button functionality.

Alternatively, you can use Chapter 3 to first guide you through one of the 'sample' measurements.

3

Running the Sample Measurement Recipes

This chapter provides instructions for making two sample measurements — a VSI measurement of a step (or other tall feature) and a PSI measurement of a mirror. After you have followed these instructions, you can experiment with other samples and measurement settings and store them in different recipe files.

To learn how to select your own measurement settings, create new recipe files, apply post-measurement processing, and change data visualization options, refer to the on-line help.

3.1 About the Example Recipe Files

For the example measurements of the step and mirror outlined in this chapter, you will use previously created recipe files to obtain your necessary measurement settings. Recipe files store all the information required to make a specific measurement and to analyze the results. The files you will use are called `DemoVSI.visrcp` and `DemoPSI.visrcp`. For the first few measurements you make, use the default settings in the recipe file. After you are comfortable with the measurement process, feel free to change the recipe file name and then adjust the settings to see how various settings will affect the measurement. For more information, see Chapter 4.

Note If you change the measurement settings and want to save them, always do so in a recipe file that has a different name than the defaults. That way, when you want to return to the defaults, you can simply re-open the `DemoVSI.visrcp` or `DemoPSI.visrcp` recipe file.

3.2 Making a VSI Measurement of a Step

Vertical Scanning Interferometry (VSI) is a measurement mode developed at Bruker that enables the measurement of samples with a considerable height range. While any surface may be measured with the VSI technique, you may achieve better results on very smooth surfaces with a PSI measurement (see the next section). For an explanation of how the VSI measurement process works, along with a description of parts suitable for measurement with the VSI technique, see *VSI Measurement Mode* on page 5.

The procedure described in this section guides you through a simple VSI measurement. The demonstration recipe file provides suitable measurement parameters for a step of approximately 10 µm in height. If you have a calibration standard of this sort (see Figure 3.1) you can use it, but any similar surface can be substituted.

1. If the system is not running, turn it on and start the Vision64 software (see page 8).

Figure 3.1: Step Standard

2. Select the arrow on the **Open** icon then select **Vision Recipe** (see Figure 3.2). Note that the default recipe file location is `C:\ProgramData\Bruker\Vision\Recipies`. If that default has been changed, you must browse to this directory to find the `DemoVSI.visrcp` file.

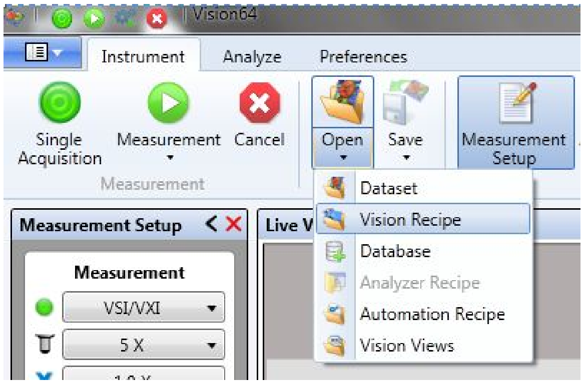


Figure 3.2: Open Recipe

3. Select the `DemoVSI.visrcp` file and then click OK. This recipe file contains all the settings that the system will use to measure a 10 µm step.

4. Place the sample on the stage platform.

5. Watching carefully from the side, adjust the z-axis until objective is a few millimeters above the surface of the step.

6. Raise the z-axis until you find focus (for further instructions, see page 13).

Note You may want to focus on a feature such as the outer edge of the standard because it's easier to find focus where there is high contrast.

7. Translate the sample with the x/y stage (see page 13) so at least one edge of the step is visible in the field of view.

8. Make certain the fringes are focused on the top of the step. If you are using a 10X or lower magnification objective, you should be able to see both sides of the step in the Intensity window. If you cannot see both sides of the step, you can determine whether the fringes are on the top surface or the bottom with the following procedure:

   - Slowly raise the z-axis so that the the fringes disappear. Keep moving upwards for a short distance.
   - If another set of fringes appears, you were focused on the bottom of the step. Stop on the top set of fringes.
   - If a second set of fringes does not appear, you were focused on the top of the step. Return to that set of fringes by slowly lowering the z-axis until the fringes reappear.

9. Adjust the tip/tilt stage until < 15 fringes are present on the top of the step and remember that you may need to adjust the focus slightly while adjusting the tip and tilt. See page 14 for further instructions.

10. Click the measure button. The default scan length is 25 microns, more than enough to measure a 10um step. Watch the **Live Video** tab and you'll see:

    a) The fringes move up and 'off' the sample. This is the back-scan portion of the measurement. If the fringes don't move 'off' the sample the back-scan is not long enough.

    b) The fringes move slowly down through the sample from the highest to lowest points. This is the measurement acquisition. The fringes must translate over the the entire field of view to measure the full surface. If the fringes don't move all the way through the surface, the scan length is insufficient.

    c) The fringes move back to the starting position and the **Live Video** tab is replaced by a new measurement tab (by default, the new measurement tab is named for the measurement type and time of acquisition (e.g. `PSI 3:23:04 PM`.)

When the measurement completes, this configuration displays the contour plot with 2D cursors (see Figure 3.4). If a single or double edged step is present, the step height will be calculated and displayed. For samples other than single or double edged steps, the 2D cursors can be used to evaluate the contour.

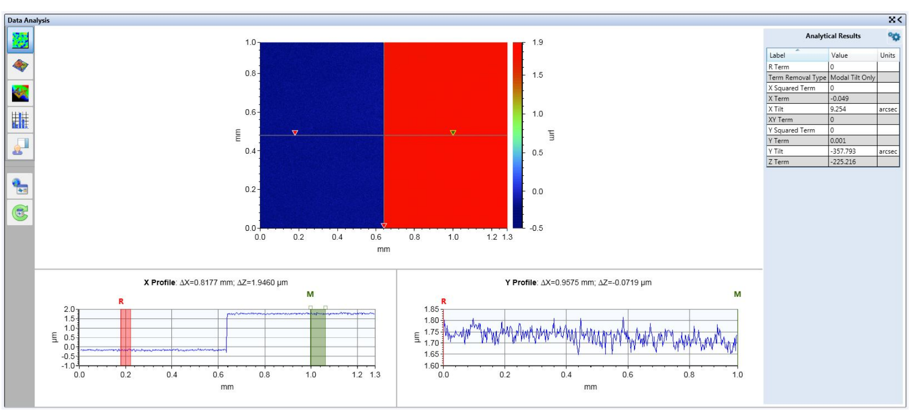
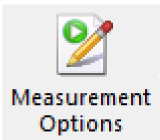


Figure 3.3: **Main Display Area** for Example VSI Measurement

Adjusting the VSI Measurement Settings

Once you are comfortable with this measurement you may wish to try making changes to some of the settings.



Select the **Measurement Setup** ribbon menu tab then click the **Measurement Options** icon to open the **Measurement Options** dialog. This dialog provides access to the current, in this case VSI, measurement settings. Experiment with these settings; they are described in detail in the on-line help.

3.3 Making a PSI Measurement of a Mirror

PSI (phase-shifting interferometry) is a measurement technique that allows you to measure extremely smooth surfaces and features, such as mirrors, optics, and polished metal. For an explanation of how the PSI measurement process works, along with a description of parts suitable for measurement with the PSI technique, see *PSI Measurement Mode* on page 5.

This procedure guides you through a simple PSI measurement. In this case, the demonstration recipe file provides suitable measurement parameters for a super-smooth reference mirror. If you have a reference mirror of this sort you can use it, but any other similar surface (such as a wafer or the flat surface of a step height standard) can be substituted.

1. If the system is not running, turn it on and start the Vision64 software (see page 8).

2. Select the arrow on the **Open** icon then select **Vision Recipe** (see Figure 3.2). Note that the default recipe file location is `C:\ProgramData\Bruker\Vision\Recipies`. If that default has been changed, you must browse to this directory to find the `DemoPSI.visrcp` file.

3. Select the `DemoPSI.visrcp` file and then click OK. This recipe file contains all the settings the system will use to measure a smooth surface.

4. Place the sample on the stage platform.

5. While watching carefully from the side, adjust the z-axis until the objective is a few millimeters above the surface.

6. Raise the z-axis until you find focus (for further instructions, see page 12 and page 13).

Note	You may want to focus on a feature such as the outer edge of the sample because it's easier to find focus where there is high contrast.

7. Make certain that you are viewing the fringes at the center of the fringe envelope; in PSI measurement mode the illumination has a much narrower bandwidth, so the fringe envelope is much wider than for VSI. The center of the fringe envelope is the location that requires the lowest intensity setting to saturate the display (turn pixels red).

8. Adjust the tip/tilt stage until < 10 fringes are present and remember that you may need to adjust the focus slightly while adjusting the tip and tilt. See page 14 for further instructions. Note that at higher magnifications the PSI fringe envelope is much shorter (you will need to be more careful to focus correctly and you may need to have < 5 fringes of tilt).

9. Click the measure button. Watch the **Live Video** tab and you'll see the fringes move across the sample.

    - If the fringes move 'off' the sample (this is much more common with higher magnifications) your focus was not in the center of the fringe envelope. Re-focus so you are at the center of the fringe envelope (or just above the center for a high magnification measurement).

When the measurement completes, this configuration removes the surface tilt and displays a 2D contour plot with the X and Y direction cross section plots (see Figure 3.4).

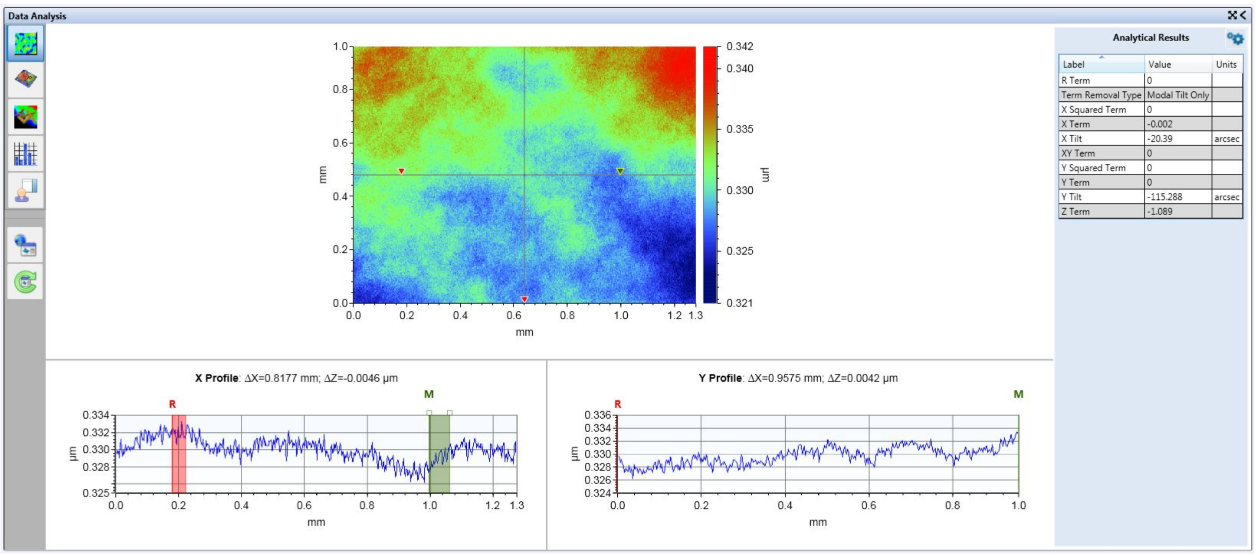
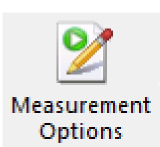


Figure 3.4: **Main Display Area** for Example PSI Measurement

Adjusting the PSI Measurement Settings

Once you are comfortable with this measurement you may wish to try making changes to some of the settings.



Select the **Measurement Setup** ribbon menu tab then click the **Measurement Options** icon to open the **Measurement Options** dialog. This dialog provides access to the current, in this case PSI, measurement settings. Experiment with these settings; they are described in detail in the on-line help.

4

Calibrating the ContourGT-K System

All the calibrations required for the ContourGT-K system are performed at the factory and these calibrations are extremely stable over time. As such, it is generally unnecessary to re-calibrate the system.

However, the Vision64 software includes algorithms that enable calibration of the scanner and various characteristics of the optics. These calibrations, and the circumstances under which they may be required, are described in this chapter.

4.1 Scanner Calibration

Recalibration of the ContourGT-K scanner requires expensive calibration standards (Figure 4.1 shows an example). Relying on the robust factory calibration of the ContourGT-K relieves you of the expense associated with acquisition and maintenance of these standards. If, however, scanner calibration is ever required it can be effected by following the process below.

Figure 4.1: Step Standard

All scanner calibrations are initiated by clicking the **Calibrate** button on the **Measurement Setup** ribbon.

To begin:

1. Place the step standard on the stage.

2. Prepare the system to perform a 1x speed VSI measurement on the step and perform a test measurement to make sure that your setup is good. (Note, the calibration algorithm performs 1x VSI measurements so your setup readies the system for calibration measurements).

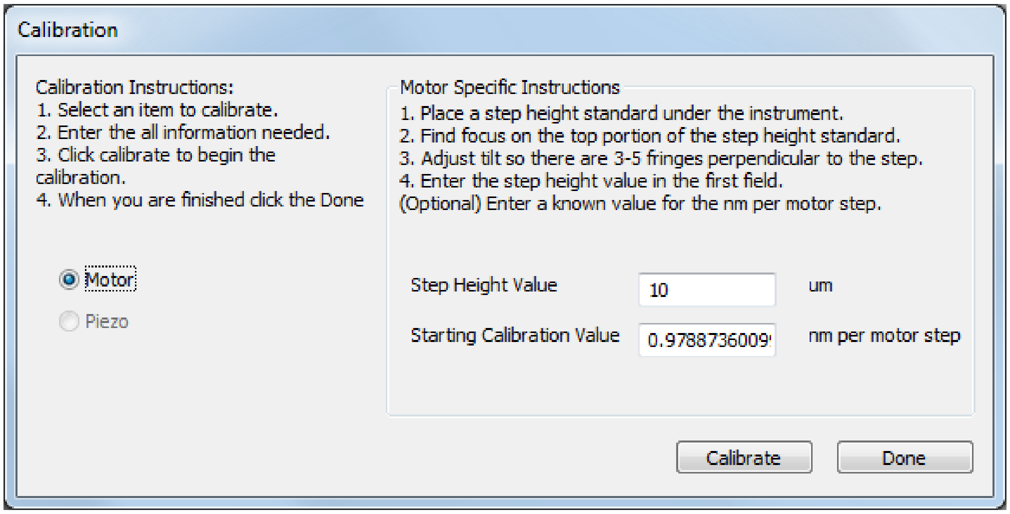


Figure 4.2: **Calibration** dialog for Motor

3. Click the calibrate button to open the **Calibration** dialog (see Figure 4.2) and select the **Motor** radio button.

4. Enter the step height of your calibration standard in the **Step Height Value** box, then click **Calibrate**.

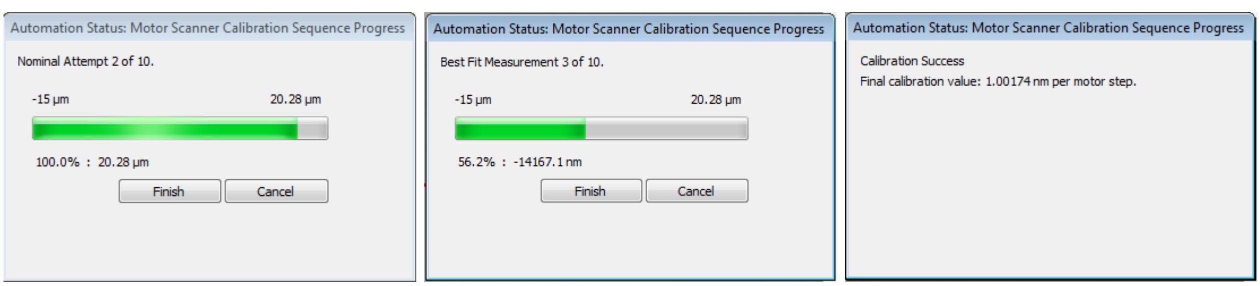
5. The calibration algorithm performs:

   a) Several measurements at the nominal calibration value.

   b) 10 'fine-tuning' measurements in a range about the nominal calibration value.

   c) A best fit to the calibration data.

   During this process the dialogs shown in Figure 4.3 are shown. Note that the final confirmation dialog appears for a few seconds and then dismisses automatically.



(a) Nominal (b) Fine Tuning (c) Confirmation

Figure 4.3: Sequence of dialogs shown during motor calibration

6. Click the **Done** button.

4.2 Reference Surface Generation

Reference surfaces record the optical aberrations in the system. The reference surface can be subtracted from measurements to eliminate system aberrations, thus providing highly accurate results. Reference files for PSI measurements are generated at the factory. If the system optics are not changed, they should be satisfactory for all but the highest accuracy work. Reference surfaces are rarely required for VSI measurements.

To generate a reference surface:

1. Place a clean super-smooth reference mirror on the stage.

   Click the **Measurement Options** icon on the **Measurement Setup** ribbon to open the Measurement Options Dialog.

2. Select the desired measurement type, either VSI or PSI (different references are required for the different measurement modes).

3. Select the optics for which the reference surface is required.

4. Click the **Generate** button in the **Measurement Parameters** tab (see Figure 4.4).

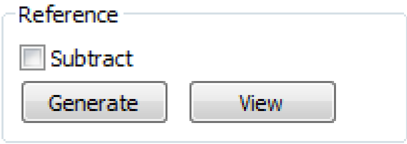


Figure 4.4: Reference Surface Parameters

5. On the **Reference Generation Setup** dialog (see Figure 4.5), select:

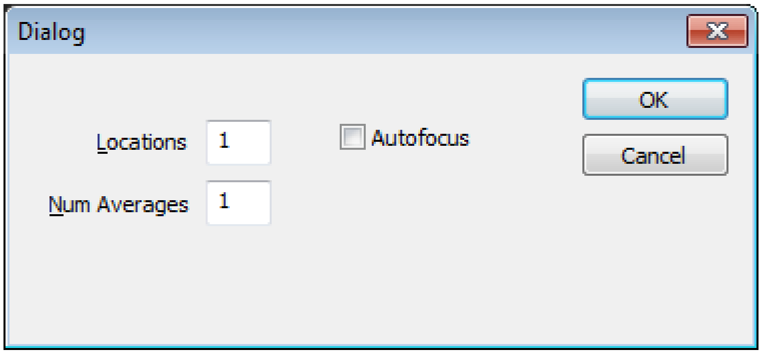


Figure 4.5: Reference Surface Parameters

   a) the number of locations to be measured.
      - The effect of imperfections in the super-smooth reference mirror are minimized by averaging multiple locations into the reference surface.
      - Using multiple locations is more often necessary for higher magnification PSI measurements, and generally four locations are sufficient even for the highest accuracy work.

    - If you choose more than '1' you will be prompted to move to a new location between each of the measurements.

  b) the number of averages for the measurement.
    - Averaging several measurements to create the reference surface can reduce the noise in the final reference surface.
    - Normally 2 to 4 averages are sufficient.

  c) whether to perform an auto-focus before the measurement.
    - It is never necessary to perform an auto-focus before a VSI reference generation but it is recommended for the generation of higher magnification PSI references.

6. At the termination of the reference generation algorithm a final dialog appears and the generated surface is displayed. Carefully check the image to ensure that the surface contains no flaws, specs of dirt etc. If it is good accept it.

4.3 Magnification Calibration

The magnifications of all the optics in your ContourGT-K system were calibrated at the factory. Further calibration is only required if you add additional objectives or FOV lenses to your system. If this situation should occur, please refer to the Magnification Calibration section of the "ContourGT-K Installation and Maintenance Manual".

5

Additional Resources

This chapter contains information on where to look and whom to contact for further information on the use of your ContourGT-K system.

5.1 On-line Help

Vision64 contains extensive on-line help. Use the on-line help system to find more detailed information on measurement types and modes, analysis functionality, and software capability.

In addition, electronic copies of your system manuals are installed on the instrument control computer.

5.2 Web Resources

- Visit www.bruker.com for information on Bruker and all the products and services it provides.
- Visit www.bruker-axs.com/white_light_interferometric_profilometers.html for optical profiler specific information.
- Visit www.bruker-axs.com/optical_and_stylus_profiler_application_notes.html to access our library of application notes and technical articles.

5.3 Advanced Training Opportunities

- Visit www.bruker-axs.com/optical_and_stylus_profiler_webinars.html for information on upcoming webinars, seminars or user meetings.
- Advanced training courses are held two or three times per year at the Tucson factory. Please contact your sales representative for further information. Alternatively, use the information request form at www.bruker-axs.com/information_request.html.

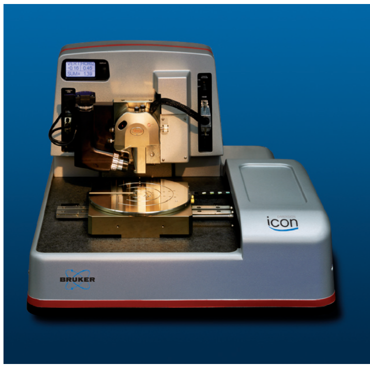
5.4 Application Support

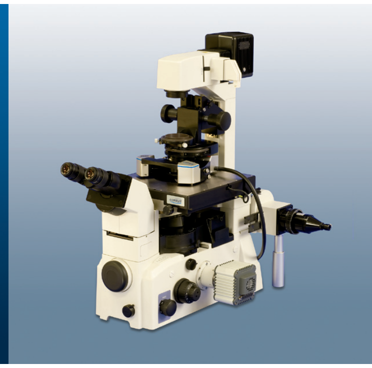
Applications support is provided via Bruker's local offices. To find contact information for your local office visit www.bruker-axs.com/nano_surfaces_support.html.

A

Hardware Support Programs

The information included in the following pages details Bruker Support Programs. Contact Bruker for more information. If you are dialing from within the U.S., call 1-800-873-9750. If you are dialing internationally, call +01-520-741-1044. Alternatively, send an email to profilersupport@bruker-nano.com.





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Product or applications user training	20% discount	20% discount	20% discount
Emergency repair visit (including all travel expenses)	Included (unlimited)	Included (one visit)	
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Repairs (parts & factory labor)	Included	Included	20% discount
Exchange/expedited repair program	Included	Included	20% discount
Stocking locations	Regional	Regional	Regional
Consumables	List price	List price	List price
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Remote diagnostic services	Included	Included	Included
Call tracking	Included	Included	Included
Telephone response time	8 business hours	8 business hours	8 business hours
Software			
Software license renewal	Included	Included	Included
Software updates (released bug fixes)	Included	Included	Included
Software revision installation	During PM visit at no charge	During PM visit at no charge	During PM visit at no charge
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