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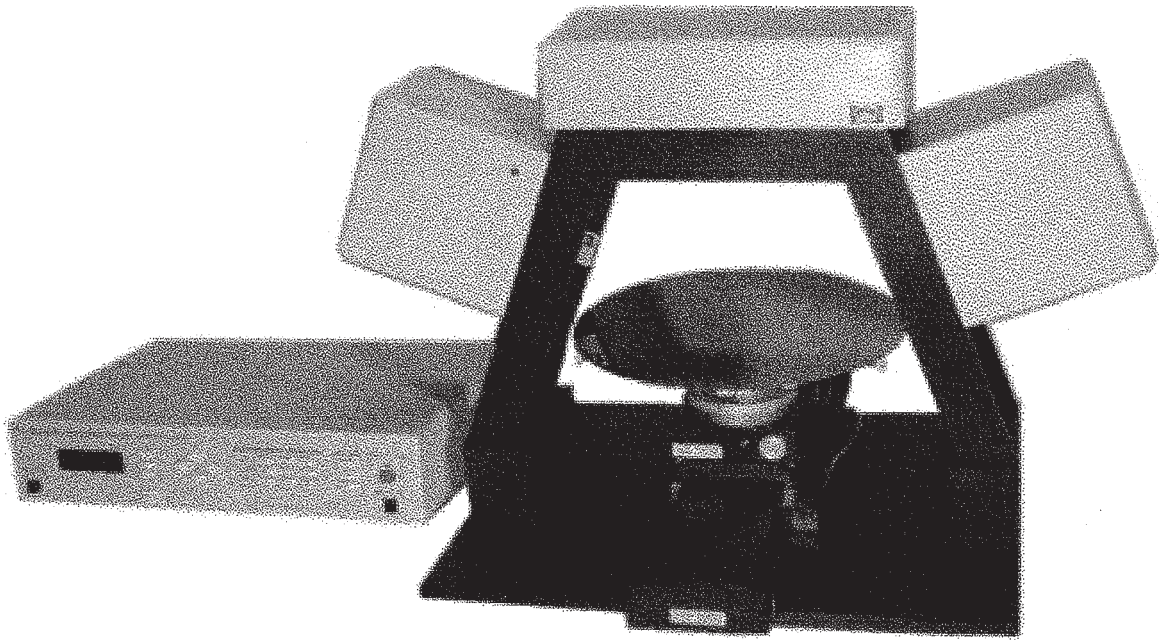
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Find the *Gaertner Scientific LSE-WS* at our website: *Click HERE*

LSE-WS STOKES WAFERSKAN™ ELLIPSOMETER

7109-C353



GAERTNER SCIENTIFIC CORPORATION

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www.GaertnerScientific.com

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Installation and Startup Outline LSE-WS Ellipsometer

1. Carefully unpack the Ellipsometer, handling the LSE-WS by its base and place it on a sturdy table in a clean, low humidity laboratory - type environment.

2. **Remove the red shipping bracket from the stage assembly.** This bracket is used during shipment to protect the stages from damage.

3. Make all instrument and computer cable connections described below before you make any AC LINE cord connections. The cables are unique so wrong connections cannot be made except for the controller Axis 1 and Axis 2.

4. Connect the top smaller rotary stage attached cable to the controller Axis 1 and the free cable from the larger linear stage to Axis 2 on the controller.

5. Connect the instrument cable to the right side module on the instrument and the 68-pin interface card installed in the computer. This interface card powers the data acquisition of the instrument and the alignment laser in the top module.

6. Connect the 24-pin IEEE-488 GPIB cable from the controller to the 24-pin PCI GPIB card installed in the computer.

7. Do not turn on the separate black HeNe power supply without first connecting the white male laser high voltage connector running from the left instrument module.

8. **Verify that the red shipping bracket is removed from the stages** and that all cables are securely connected between the instrument, controller and computer.

9. Plug the AC line cords into good, stable AC power outlets (a surge protector is recommended). Turn on the computer, controller and the separate black laser power supply.

10. Run the WAFERSKAN™ software by double clicking on the GEMP Program Icon. The software will automatically initialize the controller and move the stages for automatic scanning. Click on the ellipsometer icon of the main page toolbar. This will open the Measurement and Calculation screen from which scanning preferences can be selected.

11. The program contains a HELP utility button that explains many program features.

Refer to the instructions in the pages that follow for detailed operating information and to any additional supplemental materials for safety, warnings and cautionary information for this instrument.

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SOLLAR CELL OR ROUGH SCATTERING SAMPLE MEASUREMENT

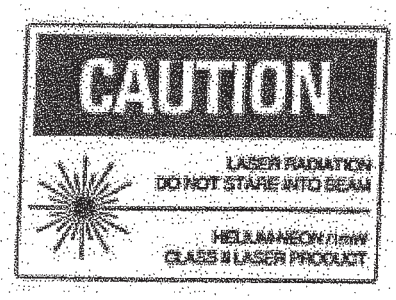
Measuring certain rough solar cells or other rough scattering samples requires more laser light to be gathered by the analyzer aperture to more of the scattered light. However, a larger aperture introduces more inaccuracy into the optical alignment making the measurement less precise. The procedure below should be used to perform measurements on scattering samples.

1. Set table height and table tilt using the reference sample or a normal polished sample with the small pinhole aperture installed in analyzer since a rough sample makes setting the table often impossible.
2. Remove the reference sample.
3. Remove the small pinhole aperture by unscrewing it from the analyzer plate and screw it into the threaded hole below the aperture for safekeeping.
4. Chose a scattering sample of similar substrate thickness so that it is not necessary to readjust the table height or the table tilt. The goal is to keep the same table alignment. Place your scattering sample on the table and gently slide the sample on the table surface without readjusting the table to locate an area that reflects as much of the laser light beam into the analyzer opening as possible. It may be helpful to observe the reflected scattering from the sample by holding a small sheet of white paper in front of the aperture opening. Direct most of light into the aperture by sliding the sample on the table. Not all scattering samples are measurable. Some are simply too rough and scatter too much light and cannot be measured.
5. Measure the scattering sample at several different regions to obtain a representative value. For measuring silicon nitride on silicon enter your expected film thickness and refractive index normally 800 Angstroms with an expected index 2.0 and 0 for K or simply press the nitride shortcut key in the program. The program should make the measurement. When the program encounters low light for the measurement it will say insufficient power for measurement. Try a different location on the sample.
6. For measuring ordinary reflective samples or the reference sample reinstall the small pinhole aperture and align the table for tilt and table height for best measurement accuracy.

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LASER SAFETY CERTIFICATION

All laser Ellipsometers supplied by Gaertner comply with CDRH requirements 21CFR 1040 for a Class II laser product emitting less than 1 milliwatt of low power radiation. As with any bright source such as the sun or arc lamp, the operator should not stare directly into the laser beam or its reflection from highly reflecting surfaces. Appropriate Warning Logotypes and Aperture Labels alert users and service personnel of the presence of laser radiation during operation. Reproductions of these labels are shown.





WARRANTY

All optical, mechanical and electrical components of Gaertner Ellipsometers, including the lasers are warranted for one year from the date of delivery. Gaertner will correct any defects in material or workmanship at no cost. Shipping charges, travel and lodging costs incurred by service personnel are not covered by this warranty. Warranty on defects in material and workmanship for any computer, computer monitor and printer supplied with the Ellipsometer is covered by its respective manufacturer and is passed through onto the user. The computer manufacturer will, at their option, repair or replace equipment that proves defective during the warranty period. Repairs necessitated by the misuse of the equipment, including use of software or interfacing not supplied by Gaertner, are not covered by this warranty. No other warranty is expressed or implied, including, but not limited to, implied warranty of merchantability and suitability for a particular purpose.
Gaertner shall not be liable for consequential damages.

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OPERATING INSTRUCTIONS

DO NOT turn on the power supply WITHOUT A LASER CONNECTED.

If you do, turn off the power supply and wait AT LEAST FIVE MINUTES before connecting the laser.

1. Make certain the power switch (front panel) is in the " 0 " (off) position.
2. Check that the voltage setting on the voltage selector switch (rear panel) matches the input voltage.
3. Insert the line cord into the receptacle (rear panel).
4. Plug the other end of the line cord into an appropriate receptacle.
5. Plug the male high voltage connector from **the** laser head into the high voltage receptacle (rear panel).
   This connection is a TIGHT FIT.
   To prevent faulty operation, be sure the male connector is FULLY SEATED.
6. To prevent the possibility of electric shock, FULLY TIGHTEN THE HIGH VOLTAGE CONNECTOR RETAINING SCREW (under high voltage receptacle).
7. Turn the power supply on by switching the power switch to " 1 " (on).

The INDICATOR LIGHT will turn on IMMEDIATELY. There will be A THREE TO SEVEN SECOND SAFETY DELAY before the laser turns **on**. On lasers equipped with a safety shutter, laser emission WILL NOT BE VISIBLE UNTIL THE SHUTTER IS OPENED.

REMOTE CONNECTOR

WARNING - PREVENTION OF ELECTRIC SHOCK: To maintain the conformance of this unit with the requirements of EN 61010 –1:1993, the power supply must be SWITCHED OFF AND DISCONNECTED FROM MAINS POWER before removing the remote plug from the socket. The remote connector is provided as a safety feature to allow REMOTE ACTUATION of the laser power supply if remote actuation is desired, ensure that the cable and remote switch are RATED FOR THE SPECIFIED SUPPLY INPUT VOLTAGE AND CURRENT. The remote switch WILL ACTUATE THE POWER SUPPLY ONLY WHEN THE MAIN POWER SWITCH IS SWITCHED ON. As supplied, the polarized remote connector plug is WIRED WITH AN INTERNAL JUMPER. If the connector is to be used with a remote external switch, modify the plug as follows:

1. Switch off power and disconnect power supply from mains power.
2. Remove remote connector plug from its socket (rear panel) by pulling straight out.
3. Press out the silver-colored locking pin.
4. Remove plug shell.
5. Remove the shorting wire from the plug terminals.
6. Drill or punch a hole in the flat end of the plug shell.
7. Slide the plug shell onto the remote connector cable.
8. Solder the cable leads to the plug terminals.
9. Insert the connector into its receptacle.

FUSING

1. The power supply is protected by an INTERNAL, NON-REPLACEABLE FUSE.
2. The fuse is rated 230 VOLTS, 1 ½ AMP, NORMAL ACTING.

IF YOU EXPERIENCE A PROBLEM ... CHECK:

1. That the indicator light is on. Indicating presence of line voltage.
2. That the laser shutter is open. If provided.
3. That the remote plug is firmly inserted in the remote connector receptacle.
4. That the remote switch is switched on- if used.
5. That the high voltage connector is firmly inserted in the high voltage receptacle.
6. That the voltage selector switch is set correctly.

If the power supply is not operated in accordance with these instructions, the function of essential safety features may be impaired. The laser power supply has no user serviceable parts within and requires no user maintenance.

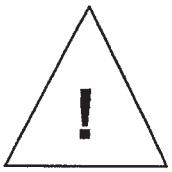
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SAFETY DIRECTIONS

Read the following safety directions in order to prevent injury to personnel and to this product.

Gaertner Scientific shall not be held responsible for any physical or material damage derived from the violation of these basic safety directions.

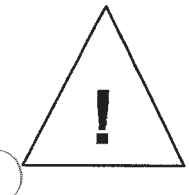
DO NOT REMOVE THE COVERS TO GAIN ENTRY TO THE INSIDE OF THE UNIT



Only personnel authorized by Gaertner Scientific may remove the covers.

There are no user serviceable parts inside.

DO NOT MANIPULATE THE CONNECTORS WITH THE UNIT CONNECTED TO AC POWER



Before manipulating the connectors (mains, feedback, etc.) make sure that the instrument is not connected to AC power.

USE PROPER AC POWER CABLES

To avoid risk, use only the AC cables supplied with this instrument.

AVOID ELECTRICAL OVERLOADS

In order to avoid electrical discharges and fire hazards, do not apply electrical voltage outside the range operating by more than ± 10%.

GROUND CONNECTION

In order to avoid electrical discharges, connect the ground terminals of all the modules to the main ground terminal. Before connecting the inputs and outputs of this instrument, make sure that all the grounding connections are properly made.

BEFORE POWERING THE INSTRUMENT, MAKE SURE THAT IT IS CONNECTED TO GROUND

In order to avoid electrical discharges, make sure that all the grounding connections are properly made.

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AMBIENT CONDITIONS

Maintain the temperature 20°C ± 2°C and humidity 20% to 85% non-condensing.

DO NOT WORK IN EXPLOSIVE ENVIRONMENTS

In order to avoid risks, damage, do not work in explosive environments.

WORKING ENVIRONMENT

This instrument is ready to be used in laboratory or clean industrial environments.

INSTALL THE INSTRUMENT IN THE RIGHT PLACE

It is recommended, whenever possible, to install the INSTRUMENT so its power switches are at a distance between 0.7mm (27.5 in.) and 1.7m (5.6 ft.) off the floor and away from direct sunlight, hot air, coolants, chemical products, blowers as well as from relays, or high electromagnetic fields (about 0.5m or 20 in.) that could damage it.

This instrument complies with the European directives on electromagnetic compatibility. Never the less, it is recommended to keep it away from sources of electromagnetic disturbance such as:

- Powerful loads connected to the same AC power line as this equipment.
- Nearby portable transmitters (Radio-telephones, Ham radio transmitters).
- Nearby radio / TC transmitters.
- Nearby arc welding machines.
- Nearby High Voltage power lines.
- Disturbance generating elements.
- Etc.

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SAFETY SYMBOLS

Symbols Which May Appear In The Manuals



WARNING: Symbol

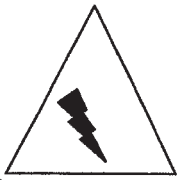
With associated text, indicating those actions or operations may hurt people or damage products.

Symbols That May Be On The Product



WARNING: Symbol

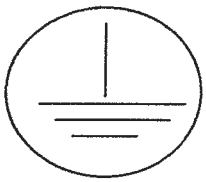
With associated text indicating those actions or operations may hurt people or damage products.



" ELECTRICAL SHOCK " Symbol

Indicates that point may be under electrical voltage.

" GROUND PROTECTION " Symbol



Indicates that point must be connected to the main ground.

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WARNING

WARNING

The rotation of objects of all types carries potential risks for operators.

Ensure the protection of operators by prohibiting access to the dangerous area and by informing the personnel of the potential risks involved.

WARNING

Do not use this ellipsometer when its motor is emitting smoke or is unusually hot to the touch or is emitting any unusual odor or noise is in any other abnormal state.

Stop using the stage immediately, switch off the motor power and then disconnect the electronics power supply.

After checking that smoke is no longer being emitted contact Gaertner service facility and request repairs. Never attempt to repair the stage yourself, as this can be dangerous.

WARNING

Make sure that this ellipsometer is not exposed to moisture and that liquid does not get into the stage.

Nevertheless, if any liquid has entered the stage, switch off the motor power and then disconnect the electronics from power supply.

Contact service@GaertnerScientific.com for service or repairs.

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WARNING

Do not insert or drop objects into this stage, this may cause an electric shock, or lock the drive.

Do not use this stage if any foreign objects have entered the stage. Switch off the motor power and then disconnect the electronics power supply.

Contact Gaertner service facility for repairs.

WARNING

Do not place this ellipsometer in unstable locations such as on a wobbly table or sloping surface, where it may fall or tip over and cause injury.

If this ellipsometer has been dropped or the case has been damaged, switch off the power and then disconnect the electronics power supply.

Contact your Gaertner service facility and request repairs.

WARNING

Do not attempt to modify this ellipsometer; this may cause an electric shock or downgrade its performance.

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CAUTIONS

CAUTION

Do not place this ellipsometer in a hostile environment such as X-Rays, hard UV...in a vacuum environment less than 10^{-2} Torr.

CAUTION

Do not place this ellipsometer in a location affected by dust, oil fumes or steam. This may cause an electric shock.

CAUTION

Do not leave this ellipsometer in places subject to extremely high temperatures or low temperatures. This may cause an electric shock.

- Operating temperature: 20 ºC. within 3 ° C

CAUTION

Do not move this ellipsometer if its power is on.

Make sure that the cables to the ellipsometer are disconnected before moving the ellipsometer. Failure to do so may cause damage and electrical shock.

CAUTION

Be careful that the stage is not bumped when it is being carried. This may cause it to malfunction.

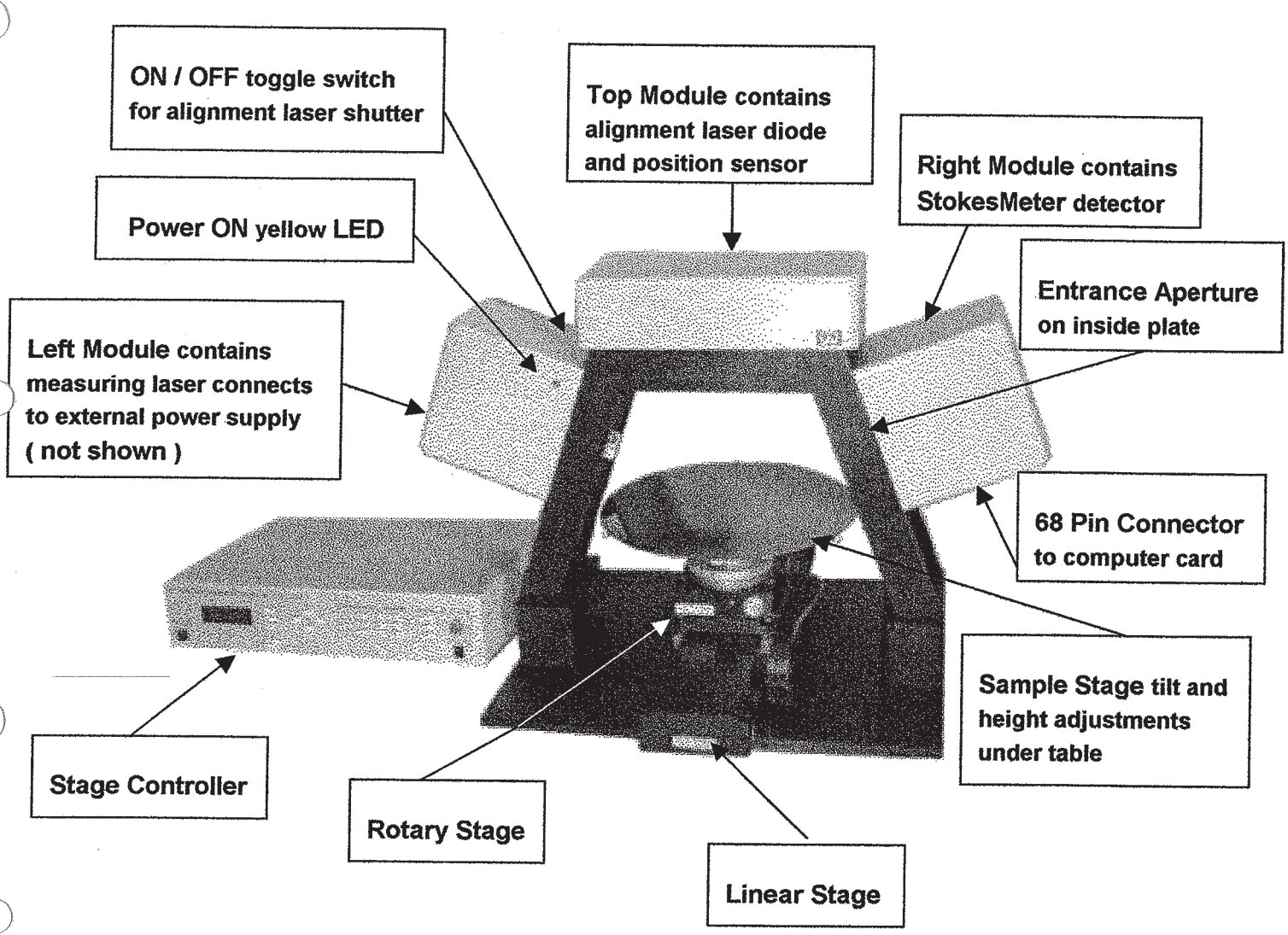
CAUTION

When the carriage is in end-of-run position, it is strongly recommended not to go beyond this point by using the manual knob as this may damage the stage mechanism.

CAUTION

Contact Gaertner service for any maintenance issues.

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LSE-WS STOKES WAFERSKAN™ ELLIPSOMETER

There are no user serviceable parts within the covers of the Ellipsometer and require no user maintenance

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LSE- WS INSTALLATION

INSPECTION

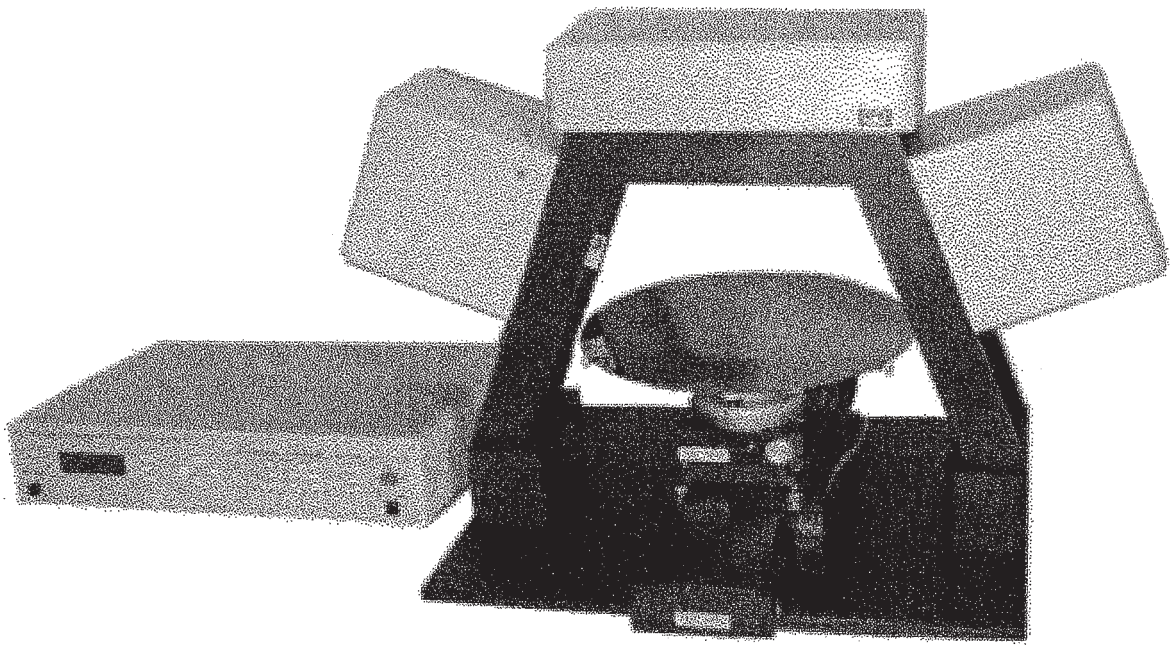
Inspect the shipping container and the ellipsometer for shipping damage. Verify that the sample wafer, controller, 3 loose interface cables, laser power supply, user manual with CD's software disks are removed from the shipping container together with the Ellipsometer in addition to the computer equipment.

LOCATION CONSIDERATIONS

The LSE-WS Ellipsometer is designed for use in either a production or laboratory facility under environmentally controlled conditions providing relatively constant room ambient temperature at 20°C (68° F) and a dry, dust-free atmosphere. The ellipsometer requires a clean, solid, level work surface. It is recommended, whenever possible, to install the INSTRUMENT so its power switches are at a distance between 0.7mm (27.5 in.) and 1.7m (5.6 ft.) off the floor and away from direct sunlight, hot air, coolants, chemical products, blowers as well as from relays, or high electromagnetic fields (about 0.5m or 20 in.) that could damage it.

The LSE-WS Ellipsometer alignment laser and StokesMeter™ detector is powered by the computer interface card that in turn is powered by the computer. The HeNe measuring laser is powered by its own separate key operated power supply. The line voltage to the equipment should be free of transients having harmonics in the range from audio frequencies to several megahertz. A voltage surge protector is recommended for the system power.

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Stokes Waferskan™ Ellipsometer LSE - WS

The 300mm Stokes WAFERSKAN™ Ellipsometer Model LSE-WS is super fast measuring 49 sites on any size wafer up to 300mm in less than 49 seconds.
The Stokes WAFERSKAN™ Ellipsometer LSE-WS is a continuation of an entirely new line of Ellipsometer based on the revolutionary StokesMeter technology (winner of Photonics Spectra and R & D 100 best new products awards). The units' elegant design offers unprecedented ease of use and Instantaneous measurement at a cost much lower that conventional production control metrology systems.

Features

- Tilt-free, focus free, hands-off operation for similar wafers.
- Fastest possible instrument for thin film measurement.
- Trouble-free, no moving parts patented StokesMeter™ measurement head.
- Accurate, stable measurements using spectrally precise laser ellipsometry.
- Simple, compact tabletop instrument - affordably priced.

An outstanding feature is the Stokes Ellipsometers compensation for small changes in angular beam deviation caused by sample thickness changes.
This permits fast, uninterrupted scanning over the entire wafer surface without the need to pause to correct for focus and tilt. When scanning similar wafers, tilt-free, focus-free; hands-off operation at tremendous speed is the obvious benefit.

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High Accuracy and Ease of Use

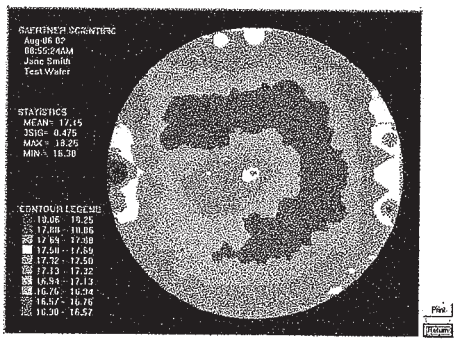
The model LSE-WS builds on the production proven Gaertner WAFERSKAN™ line of Ellipsometer in widespread use throughout the world. From thin gate oxides only tens of angstroms thick-to-thick polyamides and photo resists Gaertner has earned a reputation for providing precise, reliable results. The model LSE-WS sets a new and even higher performance standard to meet today's more demanding metrology applications.
Single Layer films such as oxides, nitrides and photo resists can be measured to sub-angstrom precision. Two, three and four layer films, with know bottom layers such as poly on oxide and oxide on poly on oxide can be measured for the thickness and refractive index of the top layer or for both thicknesses. New Windows software enhances ease of use.

Speed and Stability

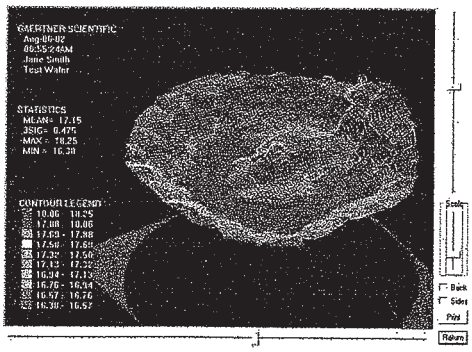
The LSE - WS Ellipsometer measures by reflecting a polarized laser beam from the sample surface at a 70° incident angle and determines the change in polarization caused by the sample virtually instantaneously. Since there are no moving parts in the StokesMeter™ measuring head the measurements are accurate and repeatable even after many months of continuous use. Precision of measurement is further enhanced by the use of a stable, spectrally pure, high signal to noise HeNe laser light source.

Great Graphics Quickly Made

The LSE-WS Stokes WAFERSKAN™ is easily operated. The user interacts with a single main program screen so the set up is easy to understand and the measurement can be quickly made. Stored recipes are easily accessed for scanning different films and patterns. Similar wafers are automatically scanned by simply pressing a single key.



2D Contour Map of Film Thickness



3D Contour Map of Film Thickness

Operator Selectable

The operator can chose 1,5,9, 49 point measurement, diameter, X - Y, or Polar Scans with up to 1000 measurement points and set the wafer edge exclusion.
The measurement results are displayed on the computer monitor and can be sent to a printer. Results stored in a text data file are displayed in a 2D Contour or 3D Map and can be rotated, tilted, reduced or enlarged for immediate viewing and interpretation.

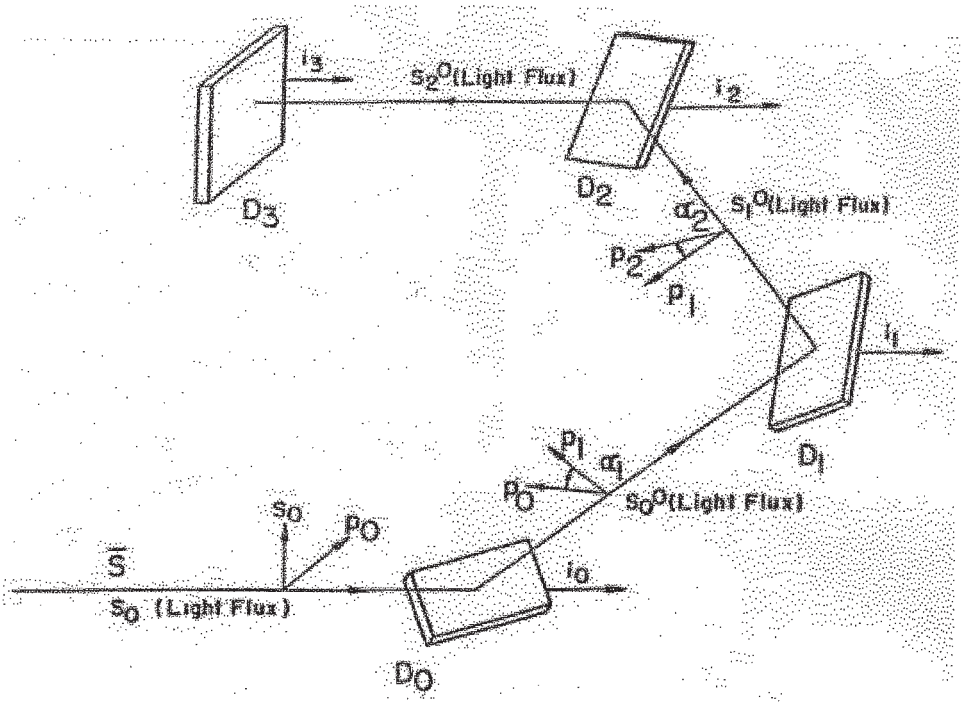
High Precision Stages

High quality stepping motor stages provide precise and repeatable positions.
The wafer is held on the optically flat table by vacuum. The stages move automatically in rapid yet precise steps under programmed computer control. Measurement time is less that one second per point including stage travel. Step precision is better than 10 microns, with the area of coverage and points within that area easily set for automatic scanning.

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DESCRIPTION OF TECHNOLOGY

This patented device uses no moving parts and no modulators to quickly and accurately determine the complete polarization state of the measuring beam.



Abstract

A photopolarimeter for the simultaneous measurement of all four Stokes parameters of light. The light beam, the state of polarization of which is to be determined, strikes, at oblique angles of incidence, three photodetector surfaces in succession, each of which is partially spectrally reflecting and each of which generates an electrical signal proportional to the fraction of the radiation it absorbs. A fourth photodetector is substantially totally light absorptive and detects the remainder of the light. The four outputs thus developed form a 4 x 1 signal vector I, which is linearly related, I = AS, to the input Stokes vector S. Consequently, S is obtained by S = A (-1) I. The 4 x 4 instrument matrix A must be nonsingular, which requires that the planes of incidence for the first three detector surfaces are all different. For a given arrangement of four detectors, A can either be computed or determined by calibration.

The clean, compact StokesMeter™ replaces a typical rotating analyzer assembly consisting of a drum, prism, encoders, switches, motor and detector and their associated electronics.
In addition, the waveplate mechanism on the polarizer arm is eliminated. This results in a fast, precise, stable no moving parts ellipsometer.

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StokesMeter™ References

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M. R. Latta and S. L. Heesacker , " Measurement of polarization components using a four-detector polarimeter. " SPIE Proc. 1166 , 207-219 (1990).

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LSE – WS CONTROLLER

Specifications

Function:
Integrated motion controller and driver.

Number of Motion Axes:
2 with phase stepper motors, up to 48 VDC, I A per axis.

Trajectory Type:
Trapezoidal velocity profile.
S - curve velocity profile.
4 MHz maximum encoder input frequency.
Digital PillFF servo loop, 0.4 ms update rate.

Stepper Motor Control:
Up to 1000 micro step resolutions per full step.

Computer Interface:
IEEE488.
16 bit digital inputs / outputs user definable, in blocks of 8.
Remote motor off input (interlock).

User Memory:
64 KB program memory 512-byte command buffer

Operating Modes:
Local mode – stand – alone operation, executing motion from the front panel.
Remote mode - executing commands received over the computer interface.
Program execution mode - execution of a stored program.

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Dimensions:
3" (2U) H x 16.5" W x 12" D (75 x 412 x 300 mm)

Power Requirements:
100 - 240VAC +/-10%, 50 / 60 Hz.
4A max.

Fuses:
.T4A / 250VAC.

Weight:
.12 lb. max. (5.4 Kg max.)

Operating Conditions:
Temperature: 0° C to 40° C.
Humidity: 20% to 90% RH, non – condensing.

Description of the ESP300 Controller
The ESP300 is an integrated controller and driver in one chassis that simplifies system hookup and provides improved reliability. The ESP300 drives and controls two axes of motion using stepper motors.

Technology

The ESP300 uses a 32-bit, floating point, DSP processor for high precision synchronized control. A digital PID-FF (feed-forward) servo loop ensures precise velocity profile tracking and accurate positioning. A 1000x programmable micro - step resolution provides ultra - smooth low - speed stepper positioning capability, and 18-bit DC motor command output ensures improved stability for precision applications.

An advanced origin search routine includes encoder index pulse consideration for precision homing. Backlash and linear error compensation eliminate repeatable system errors.

Auto – Configuration
The ESP300 motion controller will automatically configure itself so no user intervention or programming of the controller is necessary other than cable connection and power up. Motion control of the stages is performed by thru the GEMP Mapping program.

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REAR PANEL DESCRIPTION

Axis Connectors (Axis 1 & 2)

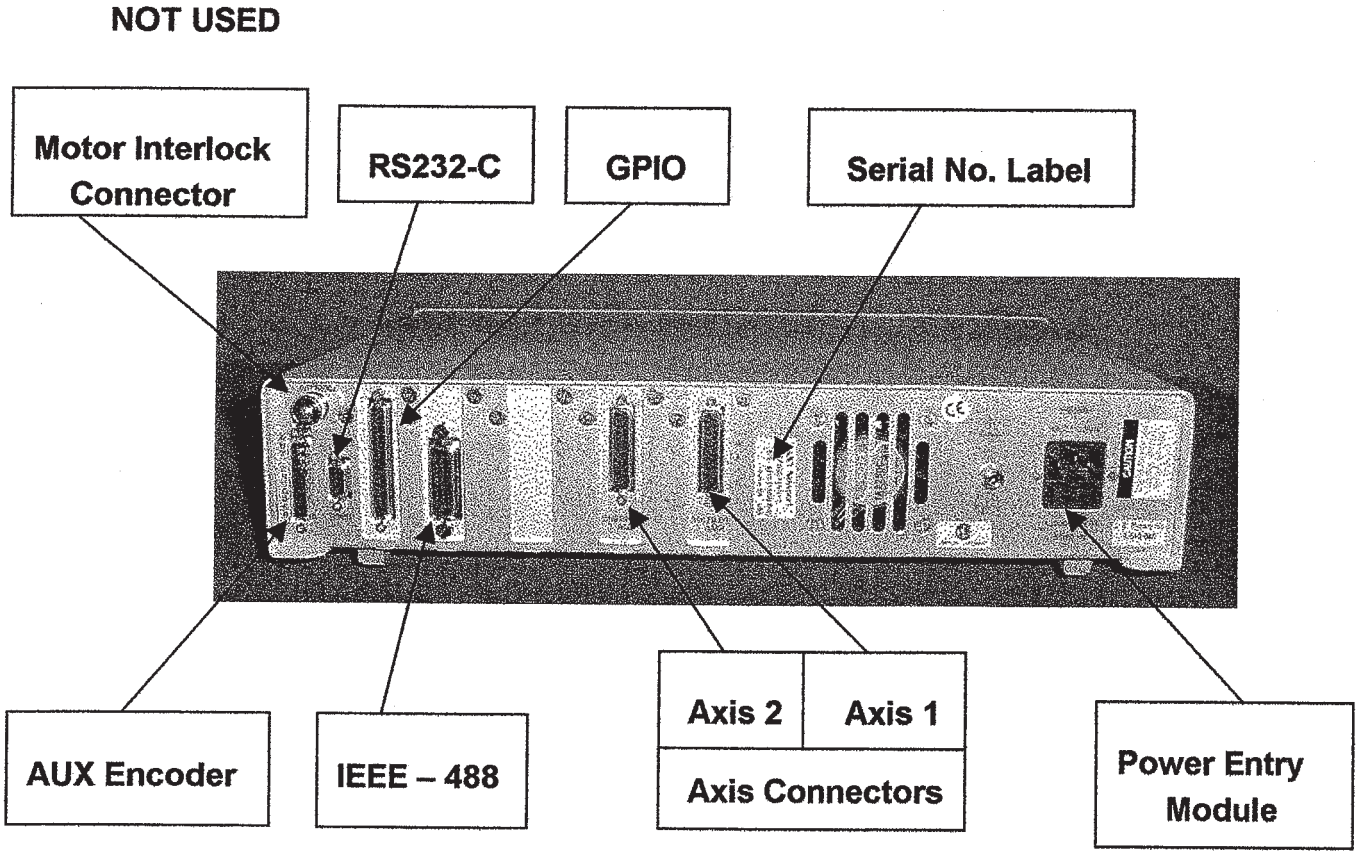
There are two 25 pin D - Sub connectors on the rear panel.

Axis 1 connects to the top rotary stage on the ellipsometer.

Axis 2 connects to the linear bottom stage on the ellipsometer.

IEEE – 488 GPIB Connector

This is a 24 pin D - Sub connector for connecting to the GPIB card in the computer.



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MEASUREMENT

The model LSE – WS STOKES ELLIPSOMETER is constructed using optical and solid state components and contains no mechanical moving parts (apart from the sample stage). This insures highly reliable measurements and long-term stability. The LSE - WS uses two low power lasers (less than 1 milliwatt) for sample measurement and for alignment. The HeNe 632.8 nm measurement beam, after reflecting from the sample, enters a patented arrangement of 4 stationary photodiode detectors that instantaneously determine the polarization state of the reflected measuring beam. A separate solid-state alignment laser beam having a wavelength of 670 nm reflects from the sample at near normal incidence sending the beam to a position sensor permitting the sample tilt and height to be adjusted via an alignment screen on the computer (see diagrams).

Laser Safety

Prior to turning on the ellipsometer please refer to the diagram noting the location of the laser beam exit apertures and the entrance aperture. The measuring beam exit aperture is located on the left module inside plate and the alignment aperture is on the top inside plate. Although the design of the instrument makes direct laser contact with the eyes unlikely; the use of low power lasers under 1 mW (less than the power output typically found in handheld laser pointers) further adds to the safety of the instrument.

Regardless: please observe laser caution to prevent any possible eye damage from looking into the laser beam or its specular reflection.

Sample Measurement

Locate and remove the red bracket used during shipping from the stage assembly.

Familiarize yourself with the sample table. Operate the two sample table tilt knobs and the table height adjustment ring located under the table. Freely manipulate the table adjustments until these adjustments are understood and easily performed. The table adjustment is the only subjective user adjustment directly affecting the accuracy of the measurements.

1. For laser safety, verify that the laser shutter switch (toggle, located on the top left module) is in the off position by gently moving it to the left. The separate HeNe laser power supply should not be turned on without first connecting it to the HeNe laser (Refer to the OPERATING INSTRUCTIONS on a separate sheet).

2. Turn on the computer, controller and the separate black laser power supply. The computer interface card supplies power to the alignment laser located in the top module and the StokesMeter™ detector located in the right module. The yellow LED will turn ON indicating possible alignment laser emission. Actual alignment laser emission is controlled by the laser shutter toggle switch.

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3. Turn the alignment laser on by gently moving the shutter switch located on the top of the left instrument module to the right. The measurement point is indicated by the alignment laser beam spot on the table surface. This beam location will be difficult to see on very clean samples but easily seen on the table surface itself. The table position can be used as a reference. Do not turn on the separate HeNe power supply without first connecting the white male high voltage connector from the left laser module to into the high voltage receptacle of the separate black power supply. With the HeNe laser connected, turn the power supply on. Open the mechanical laser shutter located at the HeNe laser exit aperture if closed.

4. Place the reference sample on the table. The sample may be centered using the table rings as a reference if necessary.

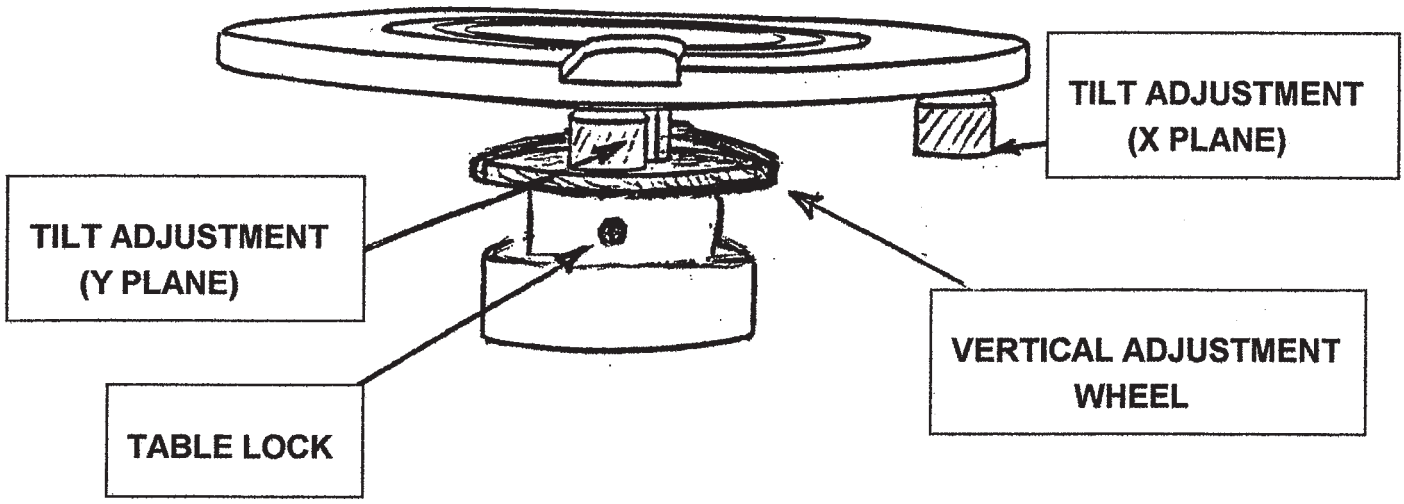
5. **Verify that the red shipping bracket is removed from the stages.**
Run the WAFERSKAN software by double clicking on the GEMP program icon. The software will automatically initialize the controller and stages for automatic measurement. Run the GEMP measurement software. Refer to the Help Utility found on the GEMP program toolbar for more detail about this program.

6. Enter the Measurement and Calculation window by clicking on the ellipsometer icon on the GEMP program toolbar.

7. Prior to any measurement, the sample table must be adjusted. This is done by clicking on the Sample Alignment button with your mouse to enter the alignment screen. First adjust the tilt by working the 2 sample table tilt knobs located under the table until the target cross is centered on the screen (see diagram). Note that tilt should always be adjusted first. Second adjust the height by working the sample table adjustment wheel or ring to obtain maximum power to the detector. This occurs when the longer horizontal bar reaches and is even with the shorter index bar. The shorter index bar indicates the maximum power that has been obtained thus far, while the longer index bar indicates the actual power that is currently entering the aperture. Raise and lower the sample table through the maximum to mark the maximum power position. For a preliminary table height alignment, observe the location of the laser beam at the 1 mm entrance aperture located on the right module inner plate and adjust the sample table height until the measurement laser beam enters this aperture.

8. Return to the GEMP program Measurement and Calculation window. Execute the measurement by clicking the Measure and Calculate button or one of the Shortcut buttons (e.g. Thin Oxide, Thin Nitride). Refer to the Help Utility and the GEMP Calculation Mode section on the pages that follow for further information.

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SAMPLE TABLE

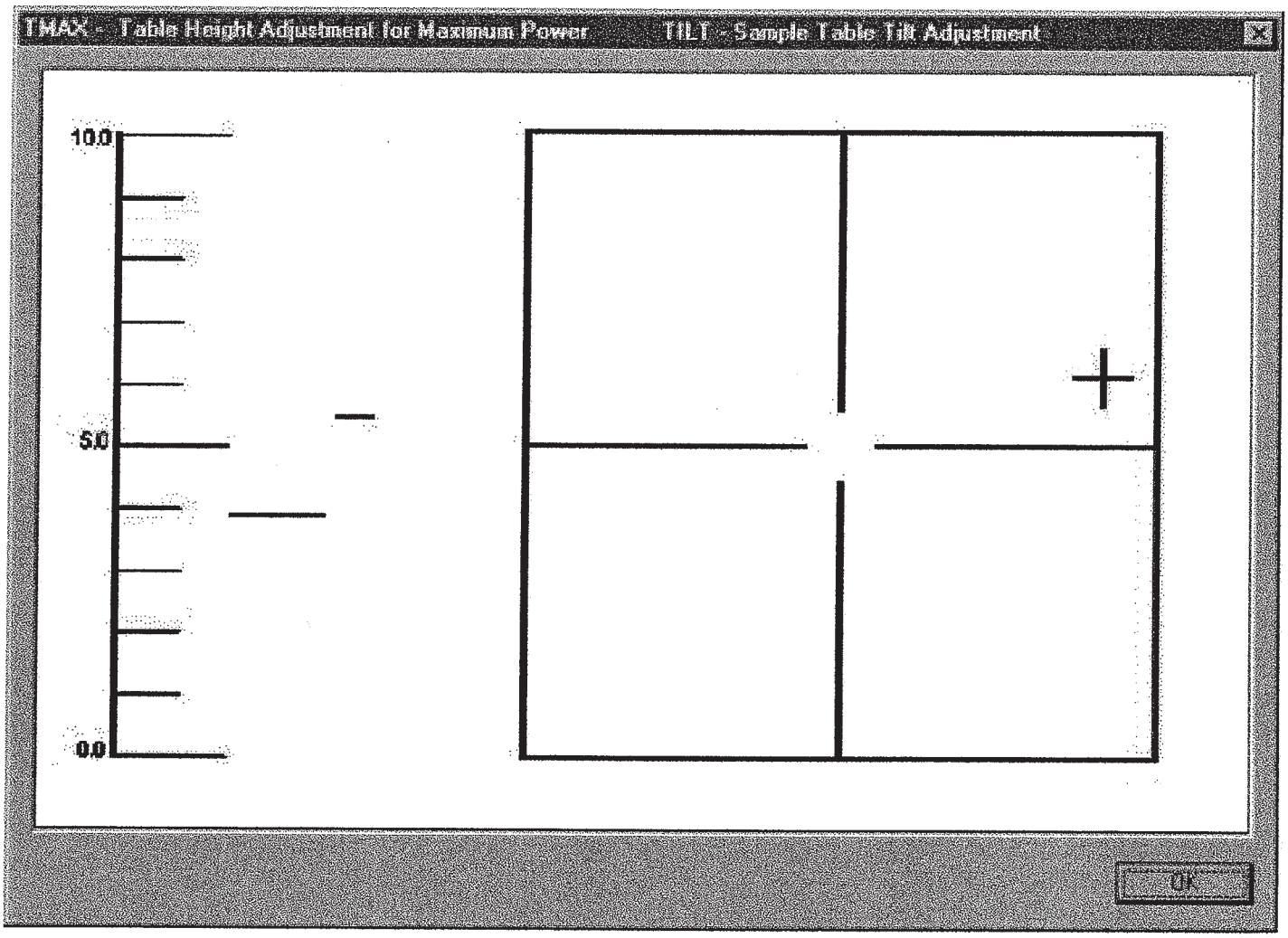
Adjustment of the sample table is done using the GEMP program and clicking on the Sample Table Adjustment button. The sample table power bar and cross target tilt adjustment screen are both displayed on the computer monitor.

Place the wafer on the table. The table rings serve as a useful reference to help center the wafer. For a preliminary " ballpark " alignment observe the laser beam reflection at the 1mm entrance aperture located on the right module inner plate. Adjust the table tilt and height until the beam enters the aperture by following the steps below.

First adjust the sample tilt by turning the tilt adjustment X and Y plane knobs under the table until the target cross is centered within the TILT screen. The tilt is always adjusted first. Wedge shaped samples may require additional shimming between the sample and table surface if more tilt is required. For these samples the tilt can be " ball parked " by observing the reflection of the top alignment laser beam against the inside top plate. The reflected beam should reenter the top plate hole in order for the tilt alignment sensor to detect the sample tilt.

Next adjust the table height by loosening the table lock screw about half turn counter clock wise and then turning the vertical adjustment wheel to raise the power bar and the shorter index bar to their highest position. The maximum position is marked by the shorter index bar when the table passes thru the maximum power position. The table height is correct when the power bar is approximately even with the shorter index bar. Be sure to tighten the Table Lock screw during scanning to keep the table in a fixed position.

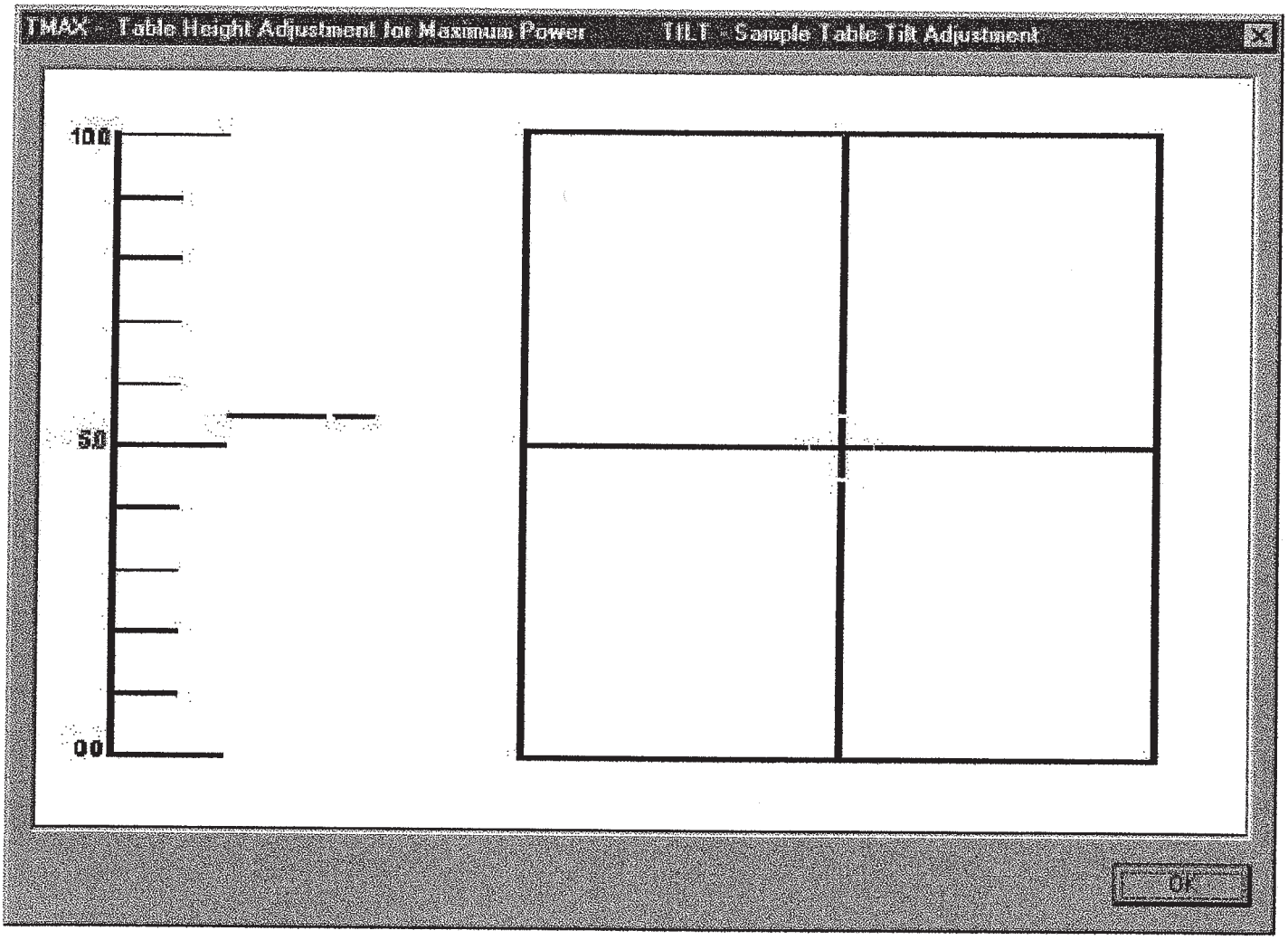
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COMPUTER SCREEN SHOWING SAMPLE TABLE OUT OF ADJUSTMENT.

Note power bar is not even with maximum power indicator and cross target is not centered.

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COMPUTER SCREEN SHOWING SAMPLE TABLE IN ADJUSTMENT.

Note power bar is even with maximum power indicator and cross target is centered.

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SOLLAR CELL OR ROUGH SCATTERING SAMPLE MEASUREMENT

Measuring certain rough solar cells or other rough scattering samples requires more laser light to be gathered by the analyzer aperture to more of the scattered light. However, a larger aperture introduces more inaccuracy into the optical alignment making the measurement less precise. The procedure below should be used to perform measurements on scattering samples.

1. Set table height and table tilt using the reference sample or a normal polished sample with the small pinhole aperture installed in analyzer since a rough sample makes setting the table often impossible.
2. Remove the reference sample.
3. Remove the small pinhole aperture by unscrewing it from the analyzer plate and screw it into the threaded hole below the aperture for safekeeping.
4. Chose a scattering sample of similar substrate thickness so that it is not necessary to readjust the table height or the table tilt. The goal is to keep the same table alignment. Place your scattering sample on the table and gently slide the sample on the table surface without readjusting the table to locate an area that reflects as much of the laser light beam into the analyzer opening as possible. It may be helpful to observe the reflected scattering from the sample by holding a small sheet of white paper in front of the aperture opening. Direct most of light into the aperture by sliding the sample on the table. Not all scattering samples are measurable. Some are simply too rough and scatter too much light and cannot be measured.
5. Measure the scattering sample at several different regions to obtain a representative value. For measuring silicon nitride on silicon enter your expected film thickness and refractive index normally 800 Angstroms with an expected index 2.0 and 0 for K or simply press the nitride shortcut key in the program. The program should make the measurement. When the program encounters low light for the measurement it will say insufficient power for measurement. Try a different location on the sample.
6. For measuring ordinary reflective samples or the reference sample reinstall the small pinhole aperture and align the table for tilt and table height for best measurement accuracy.

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Gaertner Ellipsometer Measurement Program (GEMP)

CALCULATION MODE

The GEMP software acquires data from the ellipsometer and calculates the ellipsometer values of Psi and Del for the measured sample. The Calculation Mode in the software offers 6 choices for converting the results of the Psi & Del measurement into a user-constructed model of the sample. The user simply clicks on the desired Calculation Mode with the computer's mouse pointer and then clicks the Calculate button after individual entries of film Thickness, film refractive index Nf and absorption Kf are entered into the sample model fields. The individual values in the setup or construction of the sample model can be repeatedly changed and recalculated until a best-fit solution for the sample is found.

Although the GEMP software permits up to 4 layers with 14 individual values to be entered into the setup fields for modeling of the sample only the 1 or 2 top unknown values can be calculated since only 2 values (Psi and Delta) are returned from the measurement. The number of unknowns can never be greater than the number known. Usually the unknowns are the top film Thickness1 and the film refractive index Nf1 with all of the other bottom 12 values entered as known parameters or fixed values. The calculated Thickness value is dependent on the accuracy of the entered known fixed values and will reflect any error in these values.

- **AutoFix Nf1** - Calculates Top Film Thickness1 and automatically measures the film refractive index Nf1 if it is in a good measurement range. If the index value is weak and unstable then it automatically defaults to the entered value and is fixed. The index value is important because its value is used to calculate the optical path or film thickness. An example would be 500Å Si02 film layer on a Silicon wafer measuring Psi 21.37 and Delta 98.713. The software would calculate a film refractive index of 1.458 and Thickness 1 of 456.50Å. Since Si02 is completely transparent at the measured wavelength of 6328Å the absorption Kf1 is zero. This same Si02 oxide film if etched down to 100Å would measure a Psi of 11.25 and Delta of 151.778. In this thickness range the refractive index measurement is unstable so this calculation mode permits the software to fix the index at its entered default value of 1.46 and calculate the thickness. A similar fixing of index would occur if this oxide were within a few hundred angstroms of the period value of 2800Å. Again the index measurement is unstable in this thickness range (within about 25% of zero thickness or period value). Conversely the best thickness range for index measurement is mid period 1400Å for Si02 and 900Å for Nitrides which have a period value of 1800Å.

- **Thickness 1 & Nf1** - Always returns a measured film refractive index Nf1 no matter how unstable and incorrect. Since the calculation of top film Thickness1 is dependent on this index value it will also be incorrect. This measurement mode is used to find an approximate value of film refractive index and thickness.

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- **Thickness1 & PsiC/DeltaC** - Always uses the entered value of film refractive index Nf1 to calculate the Top Film Thickness1. In addition the software also calculates one of the measured values of PsiC or DeltaC. The agreement between the measured Psi or Delta and the calculated values of PsiC or DeltaC gives an indication of the correctness of the value of index and other values in the model of the sample. This mode will give the best repeatability in thickness and if the index value is correct then this mode also gives the best and most stable film thickness measurement. This mode can be used to measure very thin films down to 1Å as well as near period films.

- **Thickness1 & Thickness2** - Calculates the top film Thickness1 and the film Thickness2. All other values are fixed in this calculation. An example would be a 600Å Nitride layer Thickness1 on 400Å of Oxide Thickness2 on a Silicon substrate.
In this mode the Thickness2 behaves much like the index and becomes unstable and difficult to measure in thinner ranges of thickness.

- **Thickness1 & Kf1** - Calculates the top film Thickness1 and the top film absorption Kf1. An example would be a polysilicon film with a approximate Thickness1 of 4000Å a known index value Nf1 of 4.0 and an absorption Kf1 of about 0.3 over a 1000Å known oxide layer on a Silicon wafer. In this example the oxide layer Thickness2 and refractive index must be accurately known. The polysilicon must be known to within 800Å since its high film index gives it a period value of only 800Å. In most cases the absorption Kf1 of the polysilicon is more volatile not as well known as the real refractive index Nf1. Since the Nf1 is more stable, the Nf1 is fixed and the absorption Kf1 is measured.

- **Substrate** - Calculates the real Ns and imaginary part of the refractive index Ks of a bare substrate. Although the measurement itself is simple the results are more complicated because most substrates including silicon form a thin native oxide layer on the surface of the substrate when exposed to air. This offsets the calculated values. In addition, microscopic surface roughness introduces polarization errors that influence the Ks value. For uniformity and simplicity well known published " book " values are generally used in place of individual user measured values. A good substrate will be flat, stable, have a smooth highly reflective surface with a different index than the film layer being measured. If the substrate is transparent like glass or fused silica then care must be taken so that the light reflected from the bottom surface does not enter the ellipsometer.
A transparent substrate can be thicker than 6mm, or have its bottom surface roughened to scatter the light or placed in optical contact with a thicker layer to absorb the unwanted bottom reflection. A 10mm thick polished fused silica plate is an example of a good substrate.

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Following is a printout of the Gaertner Ellipsometer Measurement Program (GEMP) help utility screens, which are accessible from within the program.

Measuring and Calculation Command or  **Button on Toolbar**

The Measuring & Calculation command or button pops up the Measurement & Calculation Dialog Box over the application window.
The Dialog Box is grouped into the following four sections:
Measurement & Calculation Control
Calculation Setup Waferskan Setup
Waferskan Data

Measurement and Calculation Control

Through this dialog group, the user can:
Set Instrument and Sample Parameters
Set Film Parameters
Save the current active parameters setting into a CSF (Calculation Setup File) file
Load a parameters setting from an existing CSF file
Save the Measured Data and current setup to a SMD (Store Measured Data) file or a TXT (Text) file
Open a saved SMD file to the applications document area by loading, or
Get the Psi & Delta and two solutions and put them into the applications document area.

Align Sample Table Button:

Align sample table Prior to Measurement via an alignment graphic screen. Prior to any measurement, the sample table must be aligned. First adjust the tilt by working the Sample Table title screws until the target cross is centered on the screen. Note that tilt should always be adjusted first. Second adjust the height by working the Sample Table height screw to obtain a maximum power to the detector. This occurs when the longer horizontal bar reaches and is even with the shorter Index Bar. The shorter Index Bar indicates the maximum power that has been obtained thus far, the longer Index Bar indicates the actual power that is currently entering the aperture. Raise and lower the Sample Table through the maximum to establish the maximum power position. For a preliminary table height alignment, observe the location of the laser beam in relation to the 1mm entrance aperture located on the right module inner plate and adjust the Sample Table height until the measurement laser beam enters the aperture.

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olor and more convenient handling of wafers.

Measurement as indicated by the current Waferskan™ Setup.
ach Scan Point is calculated using the current calculation Setup.
displayed on the right side of the screen in the Waferskan™
be stored as the Data File CurrentData.wdf.

Motion may be Halted at any time by using the Stop Scan Button.

Psi and Delta through the Ellipsometer and displays them.

s with the current parameters setting using the Psi & Delta and

tion Button:
Psi and Delta through the Ellipsometer and displays them and does
ent Calculation Mode and parameter setting using the Psi & Delta
the Automatic Data Storing is set (or checked), the Psi & Delta,
will be put into the application window's document area.
utton:
Delta and the two solutions (if there are calculated solutions) into
document area.
oring Data field is set (or checked), this button is not available
g Data field is cleared (or unchecked).
Checkbox:
es to the Load Wafer Position after scanning is complete.
Checkbox:
Psi- Delta and the calculation results into the application window's

Fields:
of the currently displayed Measurement Data. Measurement site
d as R (mm) and Theta (deg) for Polar Coordinates or as X (mm)
ar Coordinates. Psi (deg) and Delta (deg) are the measured

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parameters setting into a CSF (Calculation Setup File) file,
g from an existing CSF file.

e Parameter Fields:

e ID, Ambient N

Thickness3, Thickness4,

measured data on the application screen's document area. (Since the
nind the Measurement & Calculation Dialog Box, the user may need to
& Calculation Dialog Box by dragging it to see part of the application
)

n:

hich parameters are unknown and are to be calculated. AutoFix Nf1
tween the Thickness1 & Nf1 mode and the Thickness1 & PsiC/DeltaC
f1 is fixed in the Thickness1 & PsiC/DeltaC mode where PsiC/DeltaC
alue of Psi or Delta based on the fixed refracted index Nf1.
mode options are available:

C,
,

File Button:

g box in which the user can type in the file name to save current
user doesn't type the file extension, *.CSF will be appended to the
ed in. For example, if the user typed test1 in the File name: field,
csf. Since this file is a normal text file, the user can use any text-editing
nts.

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alculation Dialog Box.

er saves, the current setting to, or loads, from a CSF file, the
ill show the associated CSF file. However, if the user changes any
, the changes will not update the associated file until the user saves
ngs to the file.

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, the user can:
meters,
an setup into a SPF (Scan Parameter File) file,
om an existing SPF file.

:

measured, Wafer Diameter, and Edge Exclusion which defines how
e of the wafer.

ich scan pattern is to be used to scan wafer. Circular, Grid, or
ailable.

ich wafer style is to be measured. Notch or Plat Styles are available.

o a File Button:

g box in which the user can type in the file name to save current
user doesn't type the file extension, *.SPF will be appended to the
eed in. For example, if the user typed test1 in the File name: field,
.spf. Since this file is a normal text file, the user can use any text-editing
nts.

ter File Button:

ox which displays all the *.SPF files if there are. The user can
click the Open button, and then the file's parameters will be loaded
erskan Setup Dialog Box.

r saves, the current setting to, or loads, from a SPF file, the

using a different calculation setup,
an data into a WDF (Waferskan™ Data File) file,
from an existing WDF file,

ls:

information to be stored with the measured data.
e, Operator, and Job Name.
ed automatically after each scan.

onal plotting utility. This button is only visible when viewing
a Diameter Scan Pattern.

nal plotting utility. This button is only visible when viewing
a Circular or Grid Scan Pattern.

ional plotting utility. This button is only visible when viewing
Circular or Grid Scan Pattern.

:

ich Waferskan™ Data Solution to be displayed.

Fields:

alculated statistical values Mean, Minimum, Maximum, and
currently displayed solution.

ad points (i.e. No Solution) contained in the Waferskan™ Data.

ckbox:

d Points from the Scan Results. Note that each Bad Point is set
Good Points.

s Button:

Delta Waferskan™ Data through the Calculation Control utility using

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ve the Measurement & Calculation Dialog Box by dragging it to see
ndow's document area.)

File Button:

g box in which the user can type in the file name to save current
user doesn't type the file extension, *WDF will be appended to the file
in. For example, if the user typed test1 in the File name: field, the
f. Since this file is a normal text file, the user can use any text-editing
nts.

ton:

ox which displays all the *.WDF files if there are. The user can
click the Open button, and then the file's data will be loaded and
an™ Data Dialog Box.

user loads a New Data File, the corresponding Calculation Setup
n™ Setup that was used to generate that data will be displayed as
rrentData.csf and Scan File: CurrentData.spf.
viously loaded Calculation Setup and Waferskan™ Setup files
.

user saves, the current setting to, or loads, from a WDF file, the
will show the associated WDF file. However, if the user changes
ameters, the changes will not update the associated file until the
changed settings to the file.

of the stages and return them to the home position at any time
mportant for safety as well as for the flexibility of canceling a scan.

& Calculation Dialog Box and returns to the main window

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p, the user can:
nsor voltages, and
rk voltages.

elds:

ensor voltages V1, V2, V3, and V4 are displayed in Volts.

s:

our quadrant voltages V5, V6, V7, and V8 are displayed in Volts.

Button:

sensor voltages present under no-light conditions.

ASERS OFF when measuring dark voltages. Internal reflections
l for. Remove Sample from sample table so that laser beams strike
sed not reflected.

alog Box and returns to the main window document area.

lain Page

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mation in the Maintenance section that follows).

by simply measuring the five calibration samples using the right side
ng the directions as prompted. Once all five samples are measured,
ation Matrix button is used to force the measured data to match the
possible.

, the user can:
amples, and

lds:

s of film thickness Df, film index Nf, substrate index Ns, and substrate
calibration samples.

ces of Nf = 1.474 Ns = 3.875 and Ks = 0018. Values are important
so Do Not Change the Refractive Indices for this sample.

Fields:

lues of the ellipsometric angles Psi and Delta as well as the
film parameters for the five calibration samples.

or to Measurement Button:

le table prior to measurement of each calibration sample.

sensor voltages for each calibration sample. First the sample table
ear, allowing sample table tilt and height to be adjusted.
oot Position. Then user will be prompted to adjust tilt to four additional
measurement is performed at each tilt position and contributes to the

adjust Sample Table Height while in the Root Position.
mple Table Height for Position A, Position B, Position C,

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s utility attempts to match the Measured Sample Data as closely as
ample Data.

e This Button Until All Calibration Samples Have Been Measured.

Polarizer Angle and Angle of Incidence Phi as well as the
or. Overall Error represents the total error in the measured
as compared to the Target Values for all five Calibration Samples.

n:

alibration data for each of the five calibration positions

alog Box and returns to the main window document area.

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n the file extension is SPF this is still a normal text file and the user program to see the contents or make changes. The SMILE.spf file irectory can serve as a template for making your own user defined scan to a text editor such as Windows Notepad or Excel. Next enter your owing the format below. When you are finished copy your custom file rectory of the GSC directory.

ws

Notch	Nurnber of Points	Wafer Diam	Edge Exclusion
ius1	Y1 or Angle1	Type of Coordinates1	
ius2	Y2 or Angle2	Type of Coordinates2	
dius N	YN or Angle N	Type of Coordinates N	

and P = polar. R and P may be in upper or lower case and r to the right of the second coordinate (i.e. full words can be r or Polar, Rat bait or Pig pin, etc.), but must reside somewhere ediately following the second coordinate. If those 20 spaces are ssumed.

re first coordinate. Negative Radius values will be converted to positive.

the SMILE.SPF File in the Pmtr subdirectory

of line0 must be the number 3 and that FlatOrNotch = 0
Notch = 1 indicates Notch.

Avsan Technology Group - Quality Instrumentation ... Guaranteed | 888-88-SOURCE | www.artisan.com

Rectangular Cartesian
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he Stokes Calibration Kit or other known thickness standards.
ure described on the following pages.

eable items within the enclosure covers of the ellipsometer or it's
Removing these covers can be dangerous exposing personnel to
especially the laser power. Also damage to equipment can result.
s therefore not permitted and will void the warranty.
vice issues to Gaertner Scientific at our web address
.com

MEASUREMENT

have a Dark Voltage that should be zero to 3 decimal places.
e factory as part of the calibration process. However the interaction
ce card and any individual computer may vary with computer model
Dark Voltage is not near zero then the Dark Voltage can be reset using
lows:

u Ellipsometer (Blank screen except for Tool Bar).

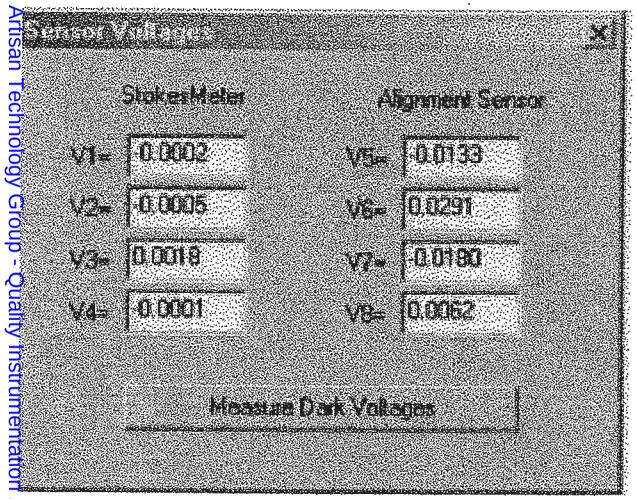
er Menu Diagnostics.

re Dark Voltages button with **both lasers ON and the Sample Table**
hat the reflection of the laser off the table does not enter the 1mm
of the ellipsometer. Measuring Dark Voltage allows the system to
ernal reflections.

oltage is reset improperly then the ellipsometer will not measure
s can happen if a sample or even the polished sample table surface
the beam to be reflected into the analyzer during the setting of the
Check that your Dark Voltages are zero with no laser light entering
pinhole but with both lasers ON.

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nd pops up the Diagnostics Dialog Box over the application window.
p, the user can view the Ellipsometer sensor voltages and
rk voltages.



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lds:

ensor voltages V1, V2, V3, and V4 are displayed in Volts.

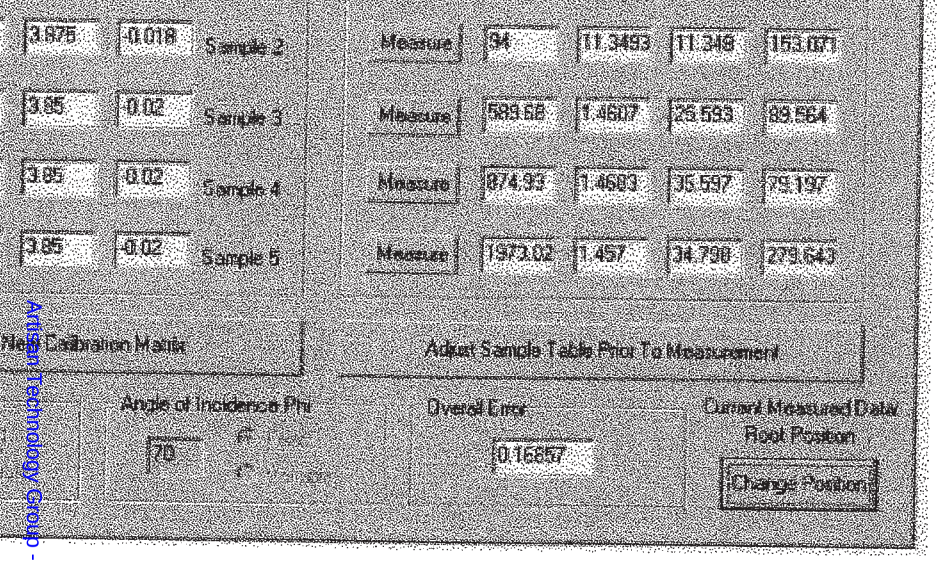
s:

our quadrant voltages V5, V6, V7, and V8 are displayed in Volts.

Button:

sensor voltages present under no-light conditions.

ASERS OFF when measuring dark voltages. Internal reflections
for. Remove Sample from sample table so that laser beams
e diffused not reflected.



ter Calibration Instructions using the optional n Kit

sed to describe the elements of the Stokes Ellipsometer and is s Polarization Vector. During the process of calibration, the Instrument ted setting the angle of incidence, polarizer angle, responsively of the of the optical detectors, and dark current offsets. The Instrument Matrix software program in conjunction with four silicon dioxide calibration thin o NIST and a quartz or glass sample.

instrument make a backup copy of the entire GSC directory and call seful in the event you need to return to the original calibration.
ge per the prior section before performing a calibration.

een from the main menu of the GEMP program (clear screen except he key sequence **Ctrl-Alt-Shift-F10**. On the left side of the screen are ple parameters used during factory calibration. If different, enter each of printed on the cover of the calibration kit samples.
m sample index values of 1.474, 3.875, and 0.018 are used for PSI ode. Do not change the refractive indices for this sample.

y simply measuring the five calibration samples using the right side of

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ices of Nf = 1.474 Ns = 3.875 and Ks = 0018. These values are important
g, so Do Not Change the Refractive Indices for this sample.

Fields:

alues of the ellipsometric angles Psi and Delta as well as the
d film parameters for the five calibration samples.

rior to Measurement Button:

ple table prior to measurement of each calibration sample.

sensor voltages for each calibration sample. First the sample table
ear, allowing sample table tilt and height to be adjusted. This first
ion. Then user will be prompted to adjust tilt to four additional positions A,
ent is performed at each tilt position and contributes to the instruments

adjust Sample Table Height while in the Root Position.
mple Table Height for Position A, Position B, Position C,

**mples will not match the target calibration value of the samples
neasured and a new matrix is calculated.**

on Matrix Button:

Meter Calibration Matrix based on the measured values of the calibration
mpts to match the Measured Sample Data as closely as possible to the
Not Use This Button Until All Calibration Samples Have Been Measured.

Polarizer Angle and Angle of Incidence Phi as well as the
n. Overall Error represents the total error in the measured
s compared to the Target Values for all five Calibration Samples.

:

libration data for each of the five calibration positions

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pe necessary on a Gaertner supplied computer.

STALLATION

are Driver on your computer using the supplied CD to enable
A/D interface board. Allow the computer to reboot to complete the
essary to install documentation but allow configuration of the NI-DAQ
nation Explorer.

ARD) INSTALLATION

**ometer interface card into your computer before the NI-DAQ
een installed and the computer rebooted**. If the interface card is
AQ software driver is installed in the computer the card will be identified
-Play device with a yellow question mark in the device manager of the
se then delete this unknown device together with the NI-DAQ software
puter, remove the card and reinstall the driver software.
rface board or card is shipped in an anti-static conductive bag.
sure the board does not come in contact with any static electrical
l ground of your computer before removing the card from the anti-static
e bag before touching the board. Try to handle the board by the edges,
ounted on the card; avoid touching the gold contacts.

power is turned off. Remove the computer cover. Remove the metal
empty PCI slot in the PC. Make sure you save the screw for the next
d again touch the metal ground of the computer chassis before allowing
ct any conductive parts of the computer. Install the card into any available
sure that the card is fully inserted and seated squarely. Screw down the
sing the slot cover screw. Replace the computer cover. Attach the cable
card projecting from the back of the computer and tighten the two
ector to the card. Attach the other end of the cable to the connector
er.

puter the card should be automatically recognized by the computer.
Measurement and Automation Explorer. View Devices and interfaces
pe shown.

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with the 24 pins GPIB interface board.
boot to complete the installation.

NSTALLATION

meter GPIB card into your computer before the GPIB software driver
he computer rebooted.
the NT-DAQ software driver.

TALLATION

er Measurement Program (GEMP) is for use with
computer monitor should be VGA with a minimum resolution
isplay the software properly. To install the program on your hard

aining the GEMP software in your drive.
menu, select RUN.
. E:\SETUP and click OK.
reate a directory \GSC on your hard drive.
stalled run the GEMP program by clicking on the program icon.
prompts.
button in the GEMP program toolbar for operating information.
lculation Mode found in this manual for an explanation of the
.

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70°.

Patented StokesMeter™ reads the complete beam polarization using no moving parts and no modulators, only 4 stationary silicon detectors so measurements are exact and stable.

Practically instantaneous. One second per point including stage travel.

Spectrally pure, stable, long lasting 6328Å HeNe Laser. Typical lifetime is more than 3 years. Similar light source used by NIST to produce calibration standards.

1mm diameter (1 x 3 millimeters on Wafer @ 70°) is standard.

Runs under Windows XP/ 2000.

Up to 300 mm diameter standard. Vacuum held (requires 5 inch Hg).

Precision Stepping Motors driven under user programmed computer control. 150mm linear and 360° rotary motion covers any point on the sample. Tiltable table permits correction for sample out of flatness up to 1° in both X and Y planes. Map any size wafer including 300 mm at 49 points in 49 seconds.

Within 10 microns.

2D/3D color maps of film thickness, refractive index and location to monitor, printer or disc file. Text data file easily exported to other programs.

Pentium PC.

0-60,000 Angstroms on substrate or on 1, 2, or 3 known sub layers.

±1 Angstrom over most of the measurement range.

±0.002 over most of the measurement range.

115V, 100V, 220V, 240V (50-60 Hz).

Height: 18 in., Width: 28 in., Depth: 20 in., Net Weight: 86 lbs., Shipping Weight: 200 lbs.

All laser Ellipsometers supplied by Gaertner comply with CDRH requirements 21 CFR 1040 for a Class II laser product emitting less than 1milliwatt of low power radiation. As with any bright source such as the sun or arc lamp, the operation should not stare directly into the laser beam or into its reflection from highly reflective surface.

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	1.485 – 1.500		5893	
A1	1.62	5.44		
	1.30	7.48	6199	Shiles
	1.39	7.65	6358	Shiles
	1.5	5.5		Greef
		2.26		
	1.43	7.28		Nyce
A14C3	2.7			
A1F3	1.38		55u	Mathis
A12O3	1.7			
Sb	3.17	4.94		
Sb2O3	2.05		?	Mathis
SB2S3	3.01		0.55u	Mathis
As2Se3	N/A	N/A	6320	Palik
As2S3	3.19 (a)	N/A	6250	Palik
As2S3	2.53 (b)	N/A		Palik
As2S3	2.84 (c)	6.2 x 10 - 6 (c)		Palik
a-As2S3	2.60	2.6 x 10 - 6	6400	Palik
As2S3	2.8		?	Mathis
	1.64 – 1.66		5893	
BaF2	1.29		5u	Mathis
BaO	1.98		?	Mathis
BaS	2.16		?	Mathis
BeO	1.72		?	Mathis
BiF3	1.74		1u	Mathis
BiF3	1.64		10u	Mathis
Bi2O3	2.55		?	Mathis
Bi2S3	1.5		?	Mathis
B2O3	1.46		?	Mathis
Cd	1.31	5.31		
CdF2	1.56		?	Mathis
CdO	2.5			
CdSe	2.4		0.6u	Mathis
CdSiO2	1.69		?	Mathis
CdS	2.4		?	Mathis
CdTe	2.99	0.351	6199	Palik
CdTe	2.873	N/A	6250	Palik
CaF2	1.2 – 1.4		?	Mathis
CaO	1.84		?	Mathis
CaO – SiO2	1.61		?	Mathis
CaS	2.14		?	Mathis
CaWO4	1.92		?	Mathis
	2.705	0.512 to 0.04		
	1.47 – 1.51		5893	
	1.47 – 1.49		5893	
	1.47 – 1.58		5893	
	1.47 – 1.48		5893	
CeF3	1.63		0.55u	Mathis
Ce2O3	1.95		?	Mathis
CsBr	1.70		?	Mathis

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CsC1	1.64		?	Mathis
CsI	1.79		?	Mathis
Na5A13F14	1.33		?	Mathis
Cr	3.4	4.4		
Cr3O3	2.25			
Co	2.35	4.40		
CoCr	1.83	3.772		
	3.10			
	1.53		5893	
Cu	0.44	3.26		
	0.09	3.39		
	0.14	3.33		
	0.28	2.76		
	0.272	3.24	6199	Palik
CuC1	1.93		?	Mathis
Cu2O	2.705		10u	Mathis
CuO	2.63		?	Mathis
CuS	1.45		?	Mathis
	1.4733		5893	
Na3AIF6	2.34		6330A	Mathis
C	2.411	(neg1.)	6439	Palik
C	2.408 (c)			
C	2.42			
	1.47		5893	
GGG	1.965	Small Value	6330	
Gd2O3	1.8		0.55u	Mathis
GaA1As 3.0				
GaAs	3.8 – 4	0.3 – 0.6		
GaAs	3.746	0.653		
GaAs	3.888	0.590		
GaAs	3.878	0.211	6199	Palik
GaAs	3.867	0.203	6262	Palik
GaAs	3.856	0.196	6326	Palik
GaAs	4.981	0.995	4416	
GaP	3.313	N/A	6300	Palik
aOFe2O33SiO2	1.857		5893	
2O33FeO3SiO2	1.801		5893	
aOA12O33SiO2	1.735		5893	
nOA12O3ASiO2	1.811		5893	
aOCr2O33SiO2	1.838		5893	
	1.516 – 1.534	0		
Ge	5.45	0.85		
	4.7	1.52		
	5.588	0.933	6199	Palik
	5.5	N/A	6358	Palik
	1.51 – 1.52			
	1.47		?	Mathis
	0.306	3.12		
	0.31	3.31		
	0.155	3.2		
	0.194	N/A (~ 3)	6199	Palik
Au	0.25	3.46		

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HfO2	2.0		0.5u	Mathis
InSb	4.249	1.799	6326	Palik
InAs	3.962	0.606	6326	Palik
InP	3.42			
InP	3.55	0.0813		
InP	3.549	0.317	6199	Palik
InP	3.530	0.299	6391	Palik
	1.83			
Ir	2.50	4.57	6199	Palik
Fe2O3	2.78		5893	
LaBr3	1.94		?	Mathis
LaF3	1.59		0.55u	Mathis
La2O3	1.09		0.5u	Mathis
PbC12	2.2		?	Mathis
PbF2	1.75		0.3u	Mathis
PbI2	2.7		?	Mathis
PbO	2.55		?	Mathis
PbSe	3.65	2.9	6199	Palik
PbS	4.29	1.48	6199	Palik
PbTe	(6.4)	(4.3)	6199	Korn & Braunst
LiBr	1.78		?	Mathis
LiC1	1.66		?	Mathis
LiF	1.391	(neg1.)	6400	Palik
LiNbO3	2.284 ord (⊥)		6439	Palik
LiNbO3	2.200 ext (||)			Palik
Li2O	1.64		?	Mathis
MgC12	1.6		?	Mathis
MgF2	1.385	0.0704		
MgO	1.7		?	Mathis
MnS	2.7		?	Mathis
	1.6			
Hg	1.719	4.697		
MgO	2.400			
MoO3	1.9		?	Mathis
NdF3	1.61		0.55u	Mathis
Ni	1.89	3.55		
Ni	1.99	3.95		
	1.56	3.40		
	1.93	3.65	6199	Palik
NiO	2.18		?	Mathis
Nb	1.8	2.11	5790	
Nb2O5	2.3		?	Mathis
	1.36			
	1.433			
	1.5 – 1.7		5893	
	1.64			
Pt	2.22	4.67		
	2.48	3.37		
	2.30	4.07	6199	Palik
	1.6			

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	1.51		5893	
	4.06	0.012		Irene
	4.535 – 4.06	0.236 – 0.012		
ed)	3.823	0.028		
	1.592 – 1.597		5893	
	1.585		5893	
	1.46 – 1.50		5893	
	1.467		5893	
	1.544		5893	
KBr	1.56		?	Mathis
KC1	1.488	(neg1.)	6400	Palik
KF	1.35		?	Mathis
KI	1.68		?	Mathis
Pr2O3	2.0		?	Mathis
	1.457	0		
Rh	2.12	5.51	6199	Palik
	1.56		5893	
RbC1	1.49		?	Mathis
A12O3	1.785		4416	
A12O3	1.765			
Sc2O3	1.88		0.5u	Mathis
CaSO42H2O	1.5205		5893	
CaSO42H2O	1.5226			
CaSO42H2O	1.5296			
	4.245	1.368		
Si	4.770	0.17	4416	
Si	3.906	0.022	6199	Palik
Si	3.893	0.022	6262	Palik
Si	3.882	0.019	6326	Palik
Si	3.870	0.018	6391	Palik
a-Si	4.1	0.213		
a-Si	4.23	0.461	6199	Palik
a-Si	(4.71)	(0.217)	6199	Palik
SiC	2 – 2.7			
SiC	2.634	N/A	6199	Palik
SiO2	1.543 ord		(6278)	Palik
SiO2	1.522 ext			Palik
SiO2	1.43 – 1.45	0		
SiO2- glass	1.457		6438	Palik
SiO2	1.455 – 1.46	0		
SiO2	1.466		4416	
SiO	1.969	0.012	6199	Palik
Si3N4	2.060		4416	
Si3N4	2.022	(negl.)	6199	Palik
Si2O3	1.55			

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ygen)	1.44 – 1.45			
s doping				
Ag	0.240 - 3	2.8 – 4.14		
Ag	0.066	4.02		
Ag	0.131	3.88	6199	Palik
AgBr	2.25		?	Mathis
AgC1	2.07		?	Mathis
Ag1	2.21		?	Mathis
NaBr	1.64		?	Mathis
NaC1	1.541		6400	Palik
NaCN	1.45		?	Mathis
NaF	1.30		0.55u	Mathis
NaOH	1.36		?	Mathis
MgO35A12O3	1.72		?	Mathis
SrF2	1.44		?	Mathis
SrO	1.87		?	Mathis
SrS	2.11		?	Mathis
Ta	2.1	2.33		
Ta2O5	2.1			
T1Br	2.3		?	Mathis
T1C1	2.78		?	Mathis
T1I	2.78			
ThBr4	2.47		5u	Mathis
ThO2	1.86		2.2u	Mathis
ThF4	1.52		?	Mathis
ThOF2	1.52		?	Mathis
SnO2	2.0	0.03		
Ti	3.00	3.62		
TiO2	2.87=n||, 2.58=n⊥		6400	Palik
TiN	1.5	2.0		
TiO	2.2			
W	3.27	3.5		
W	3.60	2.89	6199	Palik
WO3	1.68		?	Mathis
Va	3.06	3.21		
	1.74			
	1.55	0		
YbF3	1.57		3.8u	Mathis
YbO3	1.86	Small Value	6330	
Zn	2.40	5.53		
Zn	2.30	4.90		
ZnSe	2.6		?	Mathis
ZnS	2.358	N/A (~ 3.6 x 10 - 6)	6199	Palik
ZnS-hex	2.38 ord	6 x 10 - 2 ord	6199	Palik
ZnS-hex	2.36 ext	N/A		Palik
ZnS-hex	2.354 ord	N/A	6250	Palik
ZnS-hex	2.358 ext	N/A		Palik
ZnTe	2.85		0.5u	Mathis
ZrO2	1.97			Mathis

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the correctness of the value of index and other values in the model of
This mode will give the best repeatability in thickness and if the
is correct then this mode also gives the best and most stable film
easurement. This mode can be used to measure very thin films down
ll as near period films.

& Thickness2 –Calculates the top film Thickness1 and the film
All other values are fixed in this calculation. An example would be a
e layer Thickness1on 400A of Oxide Thickness2 on a Silicon
n this mode the Thickness2 behaves much like the index and becomes
difficult to measure in thinner ranges of thickness.

& Kf1 –Calculates the top film Thickness 1 and the top film
Kf1. An example would be a polysilicon film with a approximate
of 4000A a known index value Nf1 of 4.0 and an absorption Kf1 of
ver a 1000A known oxide layer on a Silicon wafer. In this example the
Thickness 2 and refractive index must be accurately known. The
must be known to within 800A since its high film index gives it a
of only 800A. In most cases the absorption Kf1of the polysilicon is
e not as well known as the real refractive index Nf1. Since the Nf1 is
the Nf1 is fixed and the absorption Kf1 is measured.

Calculates the real Ns and imaginary part of the refractive index Ks of
rate. Although the measurement itself is simple the results are more
because most substrates including silicon form a thin native oxide
surface of the substrate when exposed to air. This offsets the
alues. In addition, microscopic surface roughness introduces
errors that influence the Ks value. For uniformity and simplicity well
shed "book" values are generally used in place of individual user
lues. A good substrate will be flat, stable, have a smooth highly
rface with a different index than the film layer being measured. If the
ransparent like glass or fused silica then care must be taken so that
ected from the bottom surface does not enter the ellipsometer. A
ubstrate can be thicker than 6mm, or have it's bottom surface
o scatter the light or placed in optical contact with a thicker layer to
nwanted bottom reflection. A 10mm thick polished fused silica plate
e of a good substrate.

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a printout of the Gaertner Ellipsometer
nt Program (GEMP) help utility screens
ccessible from within the program

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alculation command or button pops up the Measurement & Calculation Dialog
on window.

oed into the following four sections:

l Calculation Control
o

lculation Control

oup the user can:
sample parameters,
s,
ctive parameters setting into a CSF (Calculation Setup File) file,
setting from an existing CSF file,
l data and current setup to a SMD (Store Measured Data) file or a TXT (Text) file
) file to the application's document area by loading, or
and two solutions and put them into the application's document area.

outton:
e Prior to Measurement via an alignment graphic screen. Prior to any
sample table must be aligned. First adjust the tilt by working the sample table tilt
rget cross is centered on the screen. Note that tilt should always be adjusted
st the height by working the sample table height screw to obtain a maximum
tor. This occurs when the longer horizontal bar reaches and is even with the
The shorter index bar indicates the maximum power that has been obtained thus
ex bar indicates the actual power that is currently entering the aperture. Raise
ple table **through** the maximum to establish the maximum power position. For a
eight alignment, observe the location of the laser beam in relation to the 1mm
located on the right module inner plate and adjust the sample table height until
aser beam enters the aperture.

to the Load Wafer Position. This position is in front of the ellipsometer's structure
r and more convenient handling of wafers.

skan Measurement as indicated by the current Waferskan Setup. The Measured
Point is calculated using the current Calculation Setup. The Scan Results will be
ght side of the screen in the Waferskan Data Dialog Box and will be stored as the
ata.wdf.

otion may be Halted at any time by using the Stop Scan button.

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tion button:
oint Psi and Delta through the Ellipsometer and displays them and does the
urrent Calculation Mode and parameter setting using the Psi & Delta and
If the Automatic Data Storing is set (or checked), the Psi & Delta, and the
ill be put into the application window's document area.

button:
Psi & Delta and the two solutions(if there are calculated solutions) into the
s document area.

atic Storing Data field is set (or checked), this button is not available until the
Data field is cleared (or unchecked).

n checkbox:
es stages to the Load Wafer Position after scanning is complete.

ge checkbox:
s the Psi- Delta and the calculation results into the application window's

y fields:
umber of the currently displayed Measurement Data. Measurement site
played as R(mm) and Theta(deg) for Polar Coordinates or as X(mm) and Y(mm)
ordinates. Psi(deg) and Delta(deg) are the measured ellipsometric parameters.
op layerThickness1(Angstroms) or the substrate refractive index Ns. Solution 2

egs, Thickness2(Angstroms), Kf1, or the substrate absorbsion Ks.

up the user can:
meters,
tive parameters setting into a CSF (Calculation Setup File) file,
setting from an existing CSF file,

le Parameter fields:
Sample ID, Ambient N

:
ess2, Thickness3, Thickness4,

and

active measured data on the application screen's document area. (Since the
is behind the Measurement & Calculation Dialog Box, the user may need to
ment & Calculation Dialog Box by dragging it to see part of the application

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ndex Nf1 is fixed in the Thickness1 & PsiC/DeltaC mode where PsiC/DeltaC
ated value of Psi or Delta based on the fixed refracted index Nf1. The following
ptions are available:

/DeltaC,
kness2,
and

<u>a file button</u>:
dialog box in which the user can type in the file name to save current
If the user doesn't type the file extension, *.CSF will be appended to the file
typed in. For example, if the user typed ***test1*** in the File name: field, the file
csf. Since this file is a normal text file, the user can use any text editing
contents.

<u>button</u>:
alog box which displays all the *.CSF files if there are. The user can select an
ck the Open button, then the file's parameters will be loaded and displayed in the
lculation Dialog Box.

he user saves, the current setting to, or loads, from a CSF file, the Setup File
ssociated CSF file. However, if the user changes any of the parameters, the
odate the associated file until the user saves the changed settings to the file.:

up the user can:
p parameters,
aferskan setup into a SPF (Scan Parameter File) file,
etup from an existing SPF file,

<u>ds</u>
o be measured, Wafer Diameter, and Edge Exclusion which defines how close to
f the wafer.

ose which scan pattern is to be used to scan wafer. Circular, Grid, or Diameter
ble.

ose which wafer style is to be measured. Notch or Flat Styles are available:

<u>s to a file button</u>:
s dialog box in which the user can type in the file name to save current
. If the user doesn't type the file extension, *.SPF will be appended to the file
typed in. For example, if the user typed ***test1*** in the File name: field, the file

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alog box which displays all the *.SPF files if there are. The user can select an
ck the Open button, then the file's parameters will be loaded and displayed in the
Dialog Box.

ne user saves, the current setting to, or loads, from a SPF file, the Scan File field
iated SPF file. However, if the user changes any of the parameters, the
odate the associated file until the user saves the changed settings to the file.:

up the user can:
ts for viewing or printing,
results of the scan,
sults using a different calculation setup,
aferskan data into a WDF (Waferskan Data File) file,
data from an existing WDF file,

s:
useful information to be stored with the measured data. Fields include Date,
d Job Name.
updated automatically after each scan.

mensional plotting utility. This button is only visible when viewing Waferskan
ter Scan Pattern.

mensional plotting utility. This button is only visible when viewing Waferskan
ar or Grid Scan Pattern.

dimensional plotting utility. This button is only visible when viewing Waferskan
ar or Grid Scan

on:
ose which Waferskan Data Solution to be displayed.

cs fields:
y the calculated statistical values Mean, Minimum, Maximum, and Standard
rrently displayed solution.

er of bad points(i.e. No Solution) contained in the Waferskan Data.

heckbox:
ide Bad Points from the Scan Results. Note that each Bad Point is set equal to
ood Points.

sults Button:

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tton:
scan results on the application screen's document area. (Since the application
e Measurement & Calculation Dialog Box, the user may need to move the
lculation Dialog Box by dragging it to see part of the application window's

a file button:
dialog box in which the user can type in the file name to save current
the user doesn't type the file extension, *.WDF will be appended to the file
typed in. For example, if the user typed ***test1*** in the File name: field, the file
wdf . Since this file is a normal text file, the user can use any text editing
contents.

utton:
alog box which displays all the *.WDF files if there are. The user can select an
ck the Open button, then the file's data will be loaded and displayed in the
alog Box.

the user loads a New Data File, the corresponding Calculation Setup and
that was used to generate that data will be displayed as Setup File:
d Scan File: CurrentData.spf. Hence the previously loaded Calculation Setup
tup files will not appear.

the user saves, the current setting to, or loads, from a WDF file, the Data File
associated WDF file. However, if the user changes any of the parameters, the
pdate the associated file until the user saves the changed settings to the file.:

motion of the stages and return them to the home position at any time during

or safety as well as for the flexibility of canceling a scan.

ement & Calculation Dialog Box and returns to the main window document area.

elp Main Page

Thank you for choosing Quality Instrumentation Guaranteed (888) 88-SOURCE | www.artisantg.com

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and pops up the **Diagnostics Dialog Box** over the application window.

up, the user can:
eter's sensor voltages, and
r's dark voltages.

fields:
four sensor voltages V1, V2, V3, and V4 are displayed in Volts.

lds:
nsor's four quadrant voltages V5, V6, V7, and V8 are displayed in Volts.

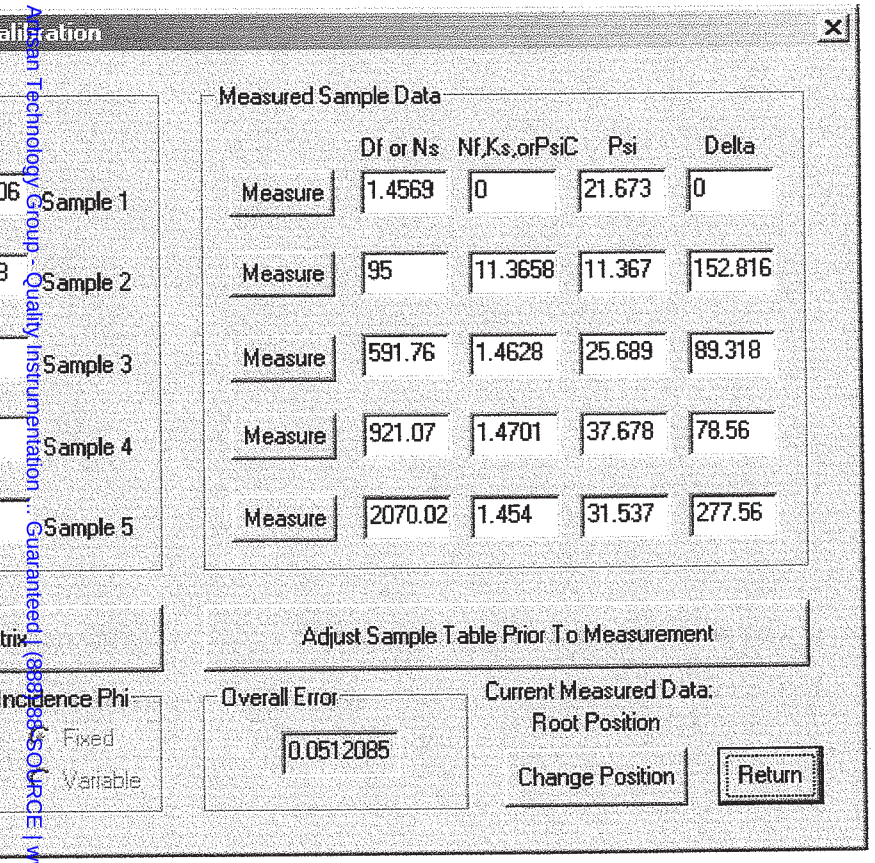
es button:
es the sensor voltages present under no-light conditions.

URN LASERS OFF when measuring dark voltages. Internal reflections must be
move Sample from sample table so that laser beams strike table and are diffused,

stics Dialog Box and returns to the main window document area.

elp Main Page

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nd pops up the **Calibration Dialog Box** over the application window.

d by simply measuring the five calibration samples using the right side of the
e directions as prompted. Once all five samples are measured, the Calculate
button is used to force the measured data to match the target data as closely as

up, the user can:
ation samples, and
meter.

elds:
values of film thickness Df, film index Nf, substrate index Ns, and substrate
he five calibration samples.

dices of Nf=1.474 Ns=3.875 and Ks=0.018. Values are important for
ot change the Refractive Indices for this sample.

ta fields:
ured values of the ellipsometric angles Psi and Delta as well as the
ulated film parameters for the five calibration samples.

Prior to Measurement button:
n sample table prior to measurement of each calibration sample.

es the sensor voltages for each calibration sample. First the sample table
will appear, allowing sample table tilt and height to be adjusted. This first position
n. Then user will be prompted to adjust tilt to four additional positions A, B, C and
is performed at each tilt position and contributes to the instruments calibration.

only adjust Sample Table Height while in the Root Position. Do Not Adjust
ght for Position A, Position B, Position C, or Position D.

ation Matrix button:
StokesMeter Calibration Matrix based on the measured values of the calibration
ty attempts to match the Measured Sample Data as closely as possible to the
ta.

This Button Until All Calibration Samples Have Been Measured.

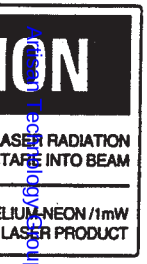
ments Polarizer Angle and Angle of Incidence Phi as well as the Overall Error of
ll Error represents the total error in the measured values of Psi and Delta as
arget Values for all five Calibration Samples.

ton:
v the calibration data for each of the five calibration positions (Root,A,B,C,D).

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e such as the sun or arc lamp, the operator should not stare directly
its reflection from highly reflecting surfaces.
Logotypes and Aperature labels alert users and service personnel of
adiation during operation. A reproduction of these labels are





WARRANTY

nd electrical components of Gaertner Ellipsometers, including the lasers
ar from the date of delivery. Any defects in material or workmanship will
at no cost. Shipping charges, travel and lodging costs incurred by
covered by this warranty. Warranty on defects in material and
mputer, computer monitor and printer supplied with the Ellipsometer is
e manufacturer and is passed through onto the user. The computer
ir option, repair or replace equipment that proves defective during the
necessitated by the misuse of the equipment, including use of software
ed by Gaertner, are not covered by this warranty. No other warranty is
luding, but not limited to, implied warranty of merchantability and
r purpose. Gaertner shall not be liable for consequential damages.

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LSE-WS CONTROLLER

oller and driver

s:
motors, up to 48VDC, l A per axis.

ofile

ler input frequency
, 0.4 ms update rate

:
esolutions per full step

uts, user definable, in blocks of8.
(interlock)

ram memory
fer

e operation, executing motion

ng commands received over

le -execution of a stored program

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" D (75 x 412 x 300 mm)

0/60 Hz

.)

°C

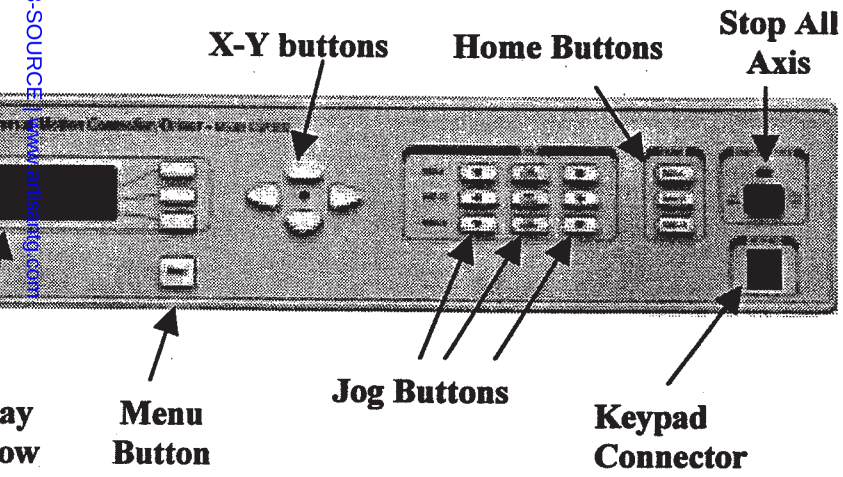
RH non-condensing

nt Panel

has a front panel with LCD display and manual control buttons.

AY

nt panel is shown below. There
display/menu section and a
t allows simple manual motion
HOMING.



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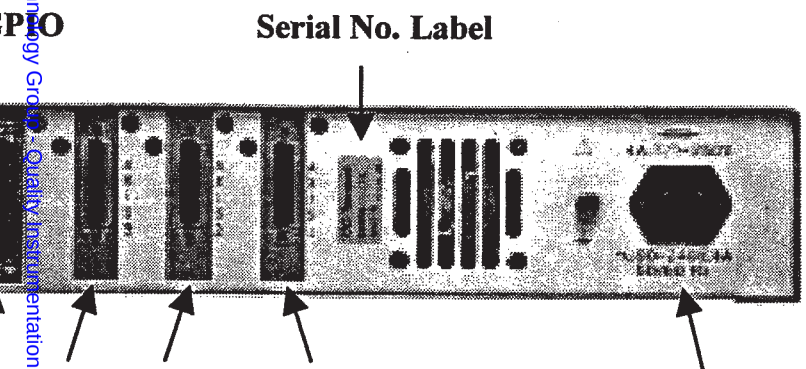
ORS (AXIS 1 & 2)

n D-Sub connectors on the rear panel
the top rotary stage on the ellipsometer
the linear bottom stage on the ellipsometer

ONNECTOR

ub connector for connecting to the GPIB card in the computer

PIO



E-488

B 24 Pin Connector

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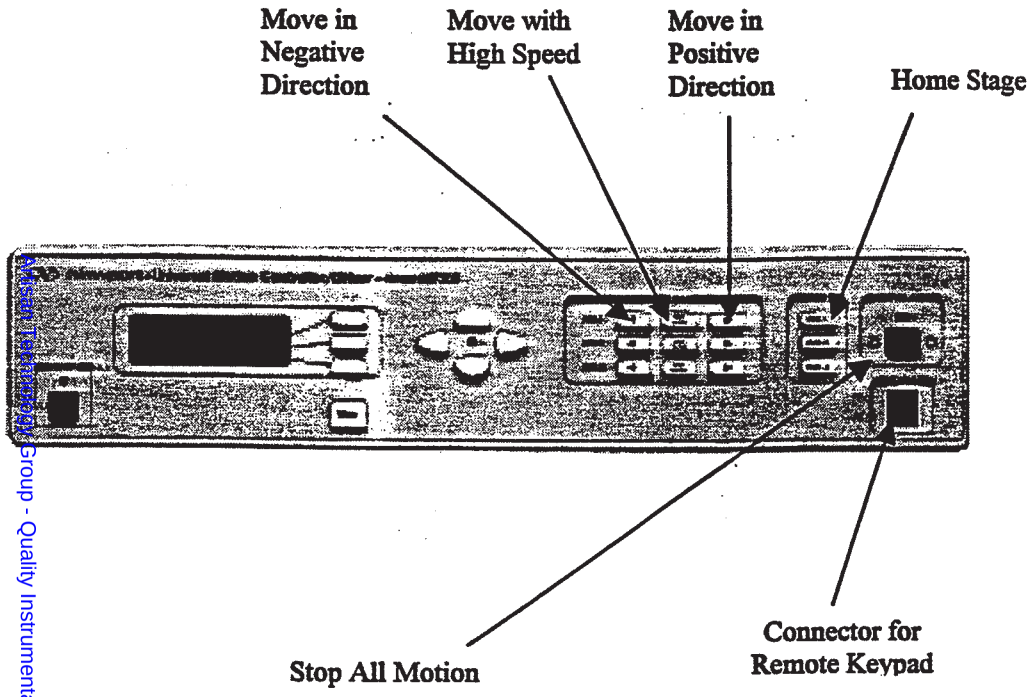


Figure 2.3: Motion from the Front Panel

Move in Negative Direction with low speed. This button can be programmed to cause motion in user definable increments or to move as long as it is pressed.

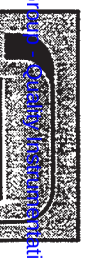
Move in Positive Direction with low speed. This button can be programmed to cause motion in user definable increments or to move as long as it is pressed.

Move with High Speed. This button is active only when pushed simultaneously with either move button above.

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Stop All Motion. When this button is pressed, all motion is stopped and the red LED above the button is illuminated temporarily. This button is equivalent to the Interlock connector on the rear of the unit. The LED is also illuminated when the interlock connector on the rear of the unit is activated.



An optional handheld keypad can be connected to the ESP300 through this receptacle

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S STOKES ELLIPSOMETER is constructed using optical and solid
ad contains no mechanical moving parts (apart from the sample stage).
reliable measurements and long term stability. The LSE-WS uses
rs (less than 1 milliwatt) for sample measurement and for alignment.
n measurement beam, after reflecting from the sample, enters a
nt of 4 stationary photodiode detectors that instantaneously determine
e of the reflected measuring beam. A separate solid state alignment
wavelength of 670 nm reflects from the sample at near normal
e beam to a position sensor permitting the sample tilt and height to
igment screen on the computer (see diagrams).

Optics Technology Group - Quality Instrumentation ... Guaranteed (888) 88-SOPTIC www.surfsantg.com

he ellipsometer please refer to the diagram noting the location of the
tures and the entrance aperture. The measuring beam exit aperture is
nodule inside plate and the alignment aperture is on the top inside
design of the instrument makes direct laser contact with the eyes
ow power lasers under 1 mW (less than the power output typically
ser pointers) further adds to the safety of the instrument. Regardless:

caution to prevent any possible eye damage from looking into the
ecular reflection.

ent

the red bracket used during shipping from the stage assembly.

with the sample table. Operate the two sample table tilt knobs and
stment ring located under the table. Freely manipulate the table
ese adjustments are understood and easily performed. The table
y subjective user adjustment directly affecting the accuracy of the

ety verify that the laser shutter switch (toggle, located on the top left
the off position by gently moving it to the left. The separate HeNe
supply should not be turned on without first connecting it to the HeNe
o the OPERATING INSTRUCTIONS on a separate sheet).

computer, controller and the separate black laser power supply. The
erface card supplies power to the alignment laser located in the top
he StokesMeter detector located in the right module. The yellow

nstrument module to the right. The measurement point is indicated by
nt laser beam spot on the table surface. This beam location will be
see on very clean samples but easily seen on the table surface itself.
osition can be used as a reference. Do not turn on the separate HeNe
ly without first connecting the white male high voltage connector from
r module to into the high voltage receptacle of the separate black
ly. With the HeNe laser connected, turn the power supply on. Open
cal laser shutter located at the HeNe laser exit aperture if closed.

ference sample on the table. The sample may be centered using the
s a reference if necessary.

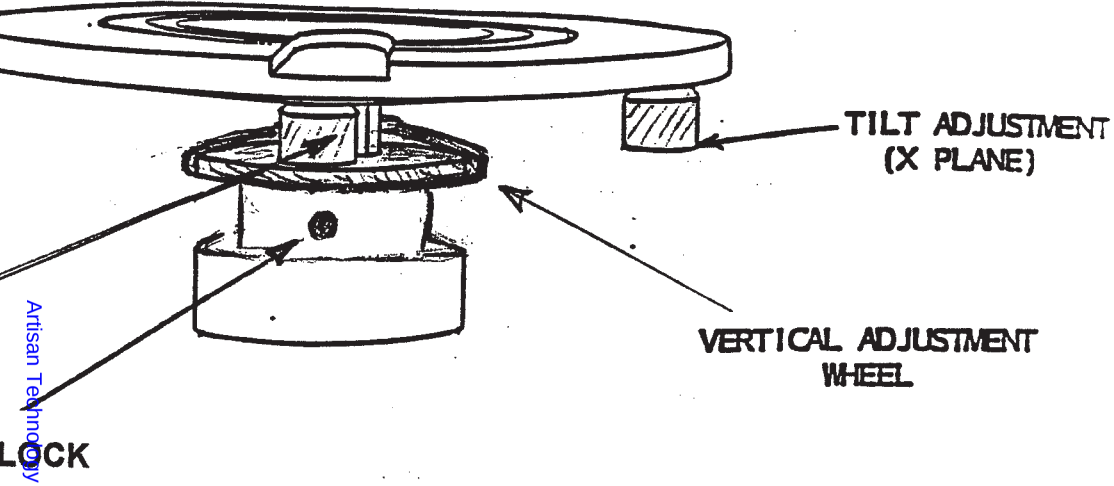
the red shipping bracket is removed from the stages
AFERSKAN software by double clicking on the GEMP program icon.
e will automatically initialize the controller and stages for automatic
t. Run the GEMP measurement software. Refer to the Help Utility
e GEMP program toolbar for more detail about this program.

easurement and Calculation window by clicking on the
icon on the GEMP program toolbar.

measurement, the sample table must be adjusted. This is done by
he Sample Alignment button with your mouse to enter the
reen. First adjust the tilt by working the 2 sample table tilt knobs
r the table until the target cross is centered on the screen (see
ote that tilt should always be adjusted first. Second adjust the height
he sample table adjustment wheel or ring to obtain maximum power
or. This occurs when the longer horizontal bar reaches and is even
ter index bar. The shorter index bar indicates the maximum power
obtained thus far, while the longer index bar indicates the actual
currently entering the aperture. Raise and lower the sample table
naximum to mark the maximum power position. For a preliminary
lignment, observe the location of the laser beam at the 1 mm entrance
ted on the right module inner plate and adjust the sample table height
surement laser beam enters this aperture.

GEMP program Measurement and Calculation window. Execute the
by clicking the Measure and Calculate button or one of the
ons (e.g. Thin Oxide, Thin Nitride). Refer to the Help Utility and the
lation Mode section on the pages that follow for further information.

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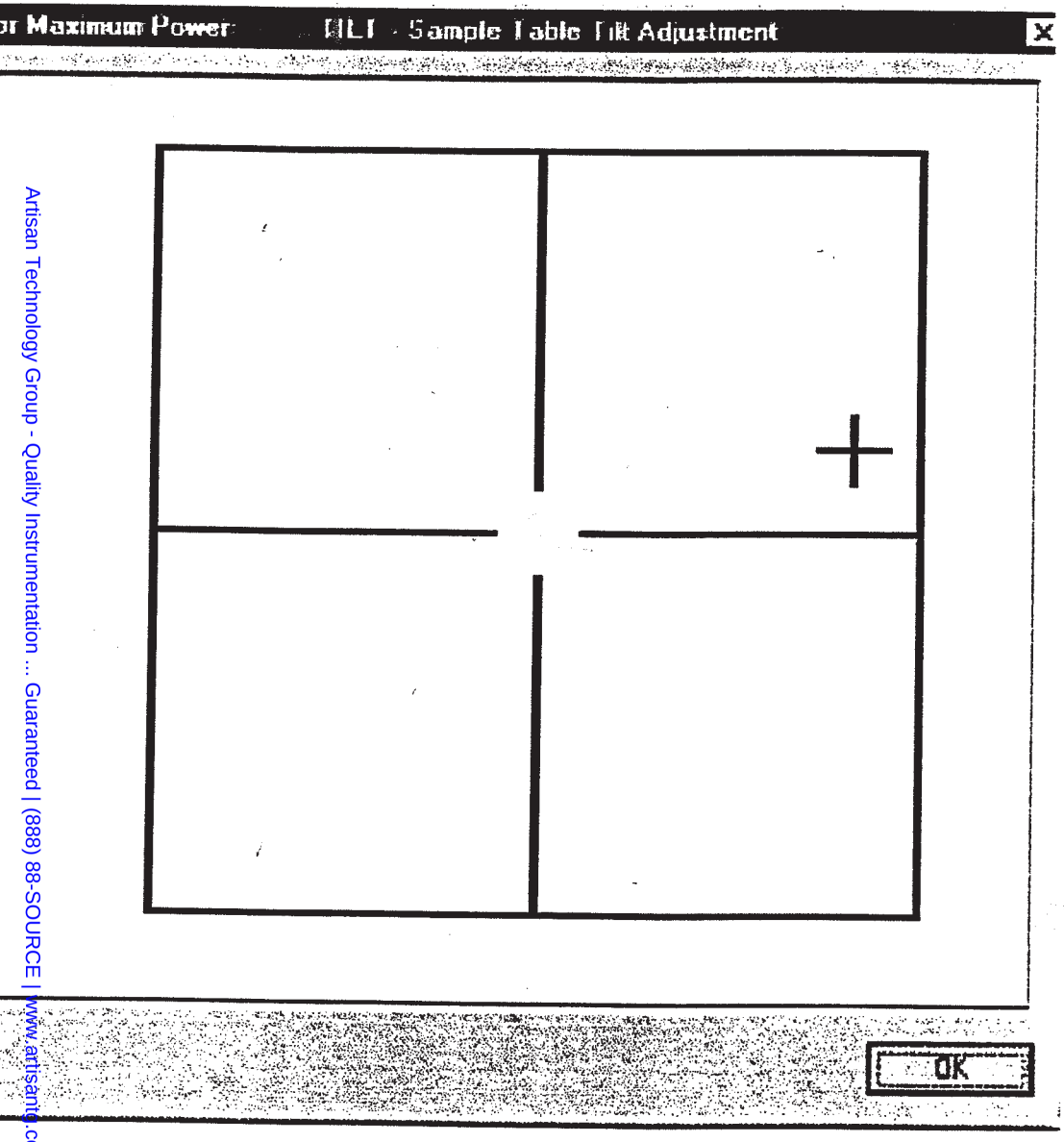
SAMPLE TABLE

ample table is done using the GEMP program and clicking on the tment button. The sample table power bar and cross target tilt re both displayed on the computer monitor.

he table. The table rings serve as a useful reference to help center the nary "ballpark" alignment observe the laser beam reflection at the 1 re located on the right module inner plate. Adjust the table tilt and n enters the aperture by following the steps below.

ble tilt by turning the tilt adjustment x and y plane knobs under the cross is centered within the TILT screen. The tilt is always adjusted l samples may require additional shimming between the sample and tilt is required. For these samples the tilt can be "ball parked" by tion of the top alignment laser beam against the inside top plate. The ld reenter the top plate hole in order for the tilt alignment sensor to t.

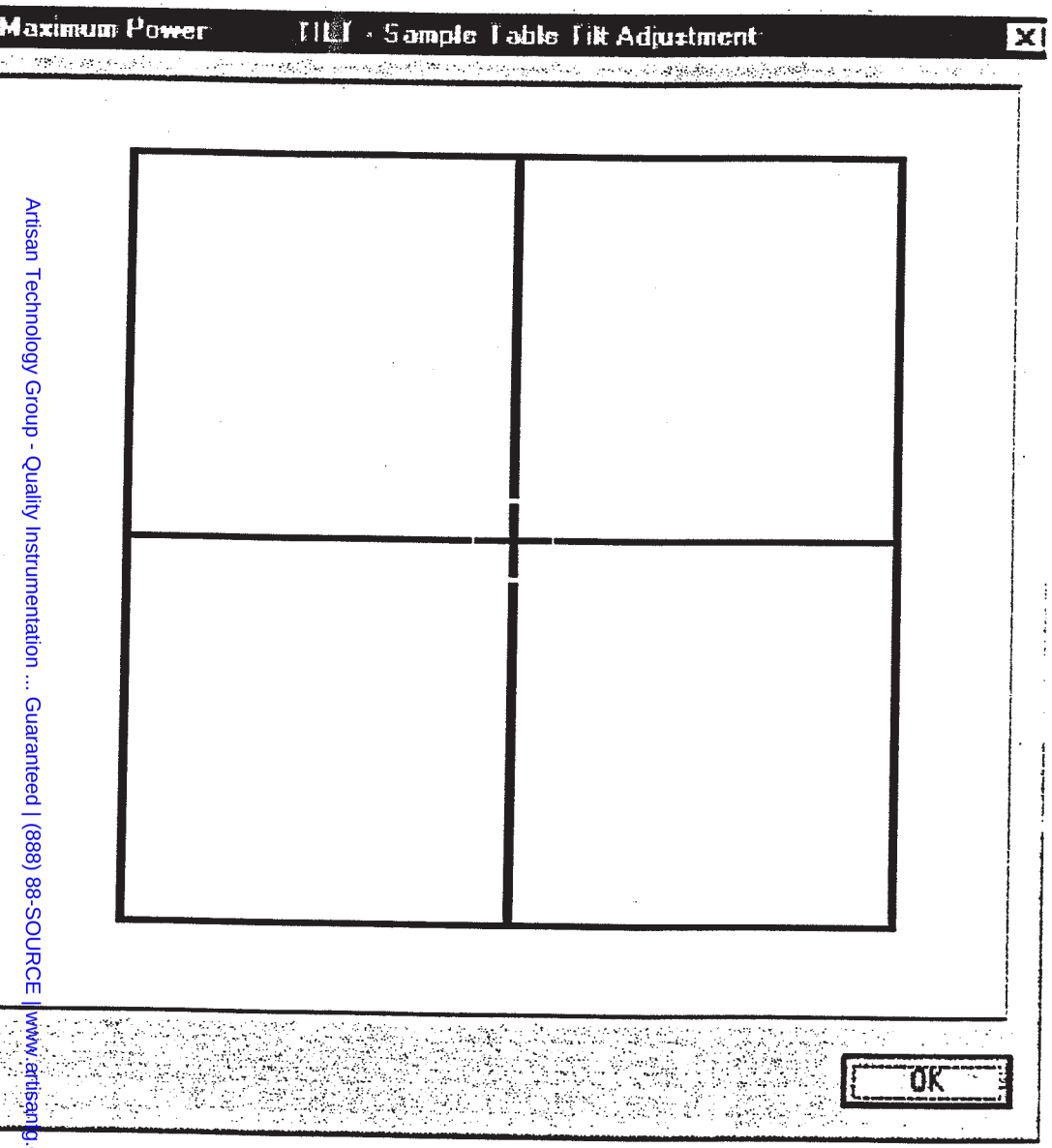
e height by loosening the table lock screw about half turn counter turning the vertical adjustment wheel to raise the power bar and the their highest position. The maximum position is marked by the hen the table passes thru the maximum power position. The table en the power bar is approximately even with the shorter index bar. he Table Lock screw during scanning to keep the table in a fixed



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EEN SHOWING SAMPLE TABLE OUT OF AJUSTMENT

ower bar is not even with maximum power indicator
and cross target is not centered



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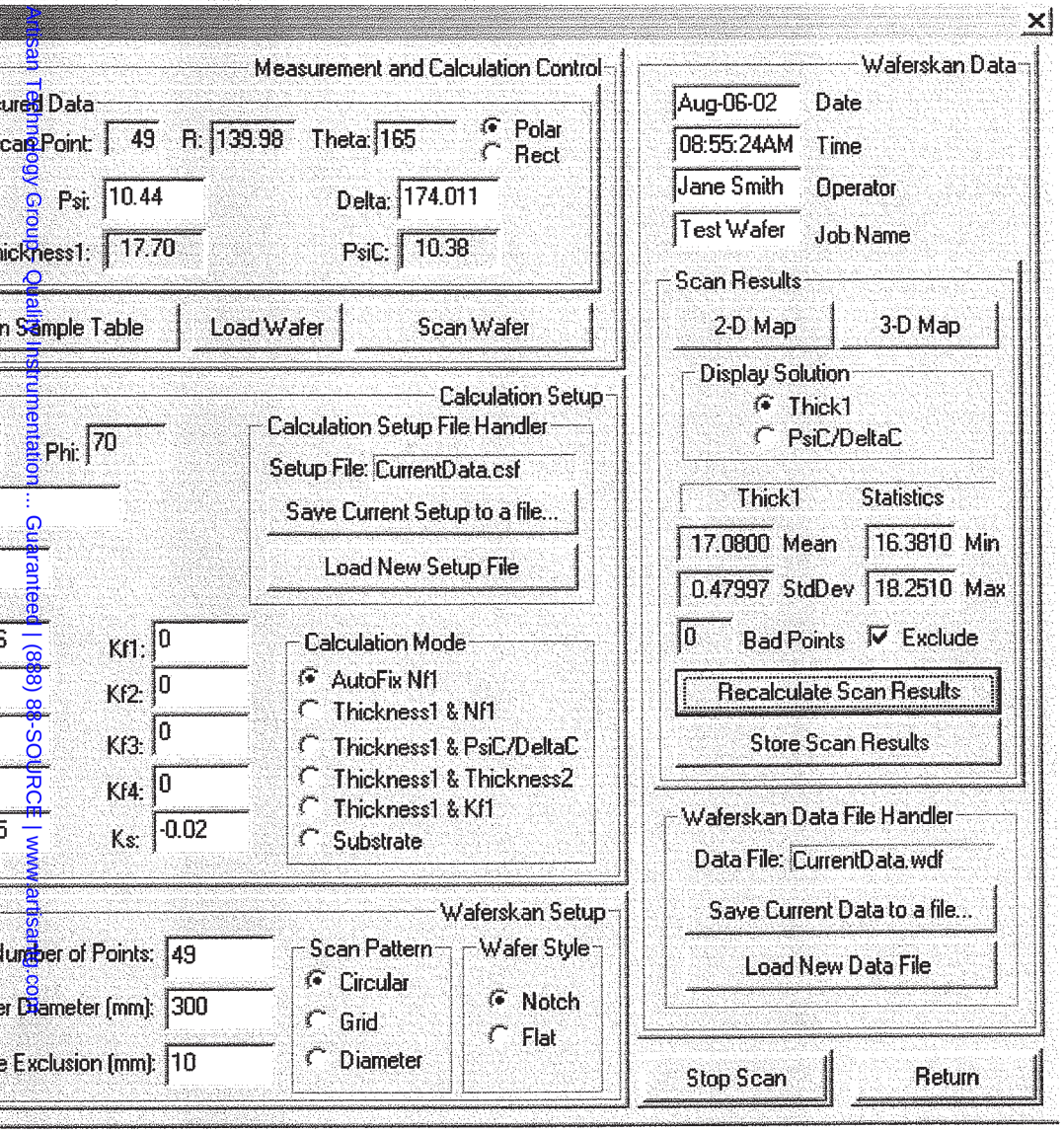
EEN SHOWING SAMPLE TABLE IN ADJUSTMENT
ower bar is even with maximum power indicator
and cross target is centered

nsors have a Dark Voltage that should be near zero. This setting is as part of the calibration process. However the interaction between ard and any individual computer may vary with computer model and e Dark Voltage is not near zero then the Dark Voltage can be reset ogram as follows:

ose Main Menu Ellipsometer
ose Ellipsometer Menu Diagnostics
k on the Measure Dark Voltages button with **both lasers ON and the ple Table positioned such that the reflection of the laser off the e does not enter the 1mm entrance aperature of the ellipsometer**. suring Dark Voltage allows the system to compensate for internal ctions.

Dark Voltage is reset improperly then the ellipsometer will not This can happen if a sample or even the polished sample table surface m to be reflected into the analyzer during the setting of the Dark t your Dark Voltages are zero with no laser light entering the analyzer th lasers ON.

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re acquires data from the ellipsometer and calculates the ellipsometer
el for the measured sample. The Calculation Mode in the software
converting the results of the Psi & Del measurement into a user-
of the sample. The user simply clicks on the desired Calculation Mode
s mouse pointer and then clicks the Calculate button after individual
kness, film refractive index Nf and absorption Kf are entered into the
s. The individual values in the setup or construction of the sample
tedly changed and recalculated until a best-fit solution for the sample

P software permits up to 4 layers with 14 individual values to be
up fields for modeling of the sample only the 1 or 2 top unknown
lated since only 2 values (Psi and Delta) are returned from the
number of unknowns can never be greater than the number known.
vns are the top film Thickness1 and the film refractive index Nf1 with
om 12 values entered as known parameters or fixed values. The
ss value is dependent on the accuracy of the entered known fixed
ect any error in these values.

1 Calculates Top Film Thickness 1 and automatically measures the
ve index Nf1 if it is in a good measurement range. If the index value
unstable then it automatically defaults to the entered value and is
index value is important because it's value is used to calculate the
or film thickness. An example would be 500 A SiO2 film layer on a
er measuring Psi 21.37 and Delta 98.713. The software would
film refractive index of 1.458 and Thickness 1 of 456.50 A. Since
mpletely transparent at the measured wavelength of 6328 A the
Kf is zero. This same SiO2 oxide film if etched down to 100 A
sure a Psi of 11.25 and Delta of 151.778. In this thickness range the
dex measurement is unstable so this calculation mode permits the
fix the index at its entered default value of 1.46 and calculate the
A similar fixing of index would occur if this oxide were within a few
gstroms of the period value of 2800 A. Again the index measurement
n this thickness range (within about 25% of zero thickness or period
nversely the best thickness range for index measurement is mid period
SiO2. and 900 A for Nitrides which have a period value of 1800 A.

& Nf1 –Always returns a measured film refractive index Nf1 no
unstable and incorrect. Since the calculation of top film Thickness 1 is
on this index value it will also be incorrect. This measurement mode is
an approximate value of film refractive index and thickness.

& PsiC/DeltaC –Always uses the entered value of film refractive

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er has a calibration data file that is unique
omputers
ometer S/N 1816-AK to computer S/N 1816-AK
ter S/N 1817-AK to computer S/N 1817-AK

KES WAFERSKAN Ellipsometer
rt

npack the Ellipsometer, handling the LSE-WS by its base and place it
table in a clean, low humidity laboratory- type environment.
d remove the red shipping bracket from the stage assembly. The
is used during shipment to protect the stages from damage.
strument and computer cable connections described below before you
AC LINE cord connections. The cables are unique so wrong
s cannot be made except for the controller Axis 1 and Axis 2.
e top smaller rotary stage attached cable to the controller Axis 1 and
ble from the larger linear stage to Axis 2 on the controller.
e instrument cable to the right side module on the instrument and the
rface card installed in the computer. This interface card powers the

e 24 pin IEEE-488 GPIB cable from the controller to the 24-pin PCI
installed in the computer.
rn on the separate black HeNe power supply without first connecting
male laser high voltage connector running from the left instrument

t the red shipping bracket is removed from the stages and that all
securely connected between the instrument, controller and computer.
AC line cords into good, stable AC power outlets and turn on the
controller and the separate black laser power supply.
AFERSKAN software by double clicking on the **GEMP program**
software will automatically initialize the controller and move the stages
tic scanning. Click on the **ellipsometer icon** of the main page toolbar.
pen the Measurement and Calculation screen from which scanning
s can be selected.
am contains a **HELP** utility button that explains many program
efer to the instructions in the pages that follow for additional
n.

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o the receptacle (rear panel).
the line cord into an appropriate receptacle.
ltage connector from the laser head into the high voltage receptacle (rear panel).

T FIT. To prevent faulty operation, be sure the male connector is FULLY SEATED.

sibility of electric shock, FULLY TIGHTEN THE HIGH VOLTAGE CONNECTOR (under high voltage receptacle).
on by switching the power switch to "I" (on).

will turn on IMMEDIATELY. There will be A THREE TO SEVEN SECOND SAFETY turns on. On lasers equipped with a safety shutter, laser emission WILL NOT BE TTER IS OPENED.

OR

ON OF ELECTRIC SHOCK: To maintain the conformance of this unit with the -1:1993, the power supply must be SWITCHED OFF AND DISCONNECTED FROM moving the remote plug from the socket.

rovided as a safety feature to allow REMOTE ACTUATION of the laser power supply. ired, ensure that the cable and remote switch are RATED FOR THE SPECIFIED VOLTAGE AND CURRENT. The remote switch WILL ACTUATE THE POWER HE MAIN POWER SWITCH IS SWITCHED ON. As supplied, the polarized remote WITH AN INTERNAL JUMPER. If the connector is to be used with a remote external follows:

isconnect power supply from mains power.
ctor plug from its socket (rear panel) by pulling straight out.
ored locking pin.

ire from the plug terminals.
the flat end of the plug shell.
o the remote connector cable.
o the plug terminals.
o its receptacle.

tected by an INTERNAL, NON-REPLACEABLE FUSE.
OLTS, 1 ½ AMP, NORMAL ACTING.

A PROBLEM..... CHECK:

on, indicating presence of line voltage
pen, if provided
rmly inserted in the remote connector receptacle
switched on, if used
nector is firmly inserted in the high voltage receptacle
switch is set correctly

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DECLARATION OF CONFORMITY

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Skokie, Illinois 60076
USA

ipsometer
15S, L116S, LSE
l

ct to Council Directives (89/336/EEC) on electromagnetic compatibility
EC) electrical equipment designed for use within certain voltage limits, as
Directive (93/68/EEC)

1326:1998 Electrical equipment for measurement, control and laboratory
Class A
1000-3-2 Harmonic current emissions, Class A
1000-3-3 Voltage fluctuations and flicker

1010-1:1993 "Safety requirements for electrical equipment for
urement, control and laboratory

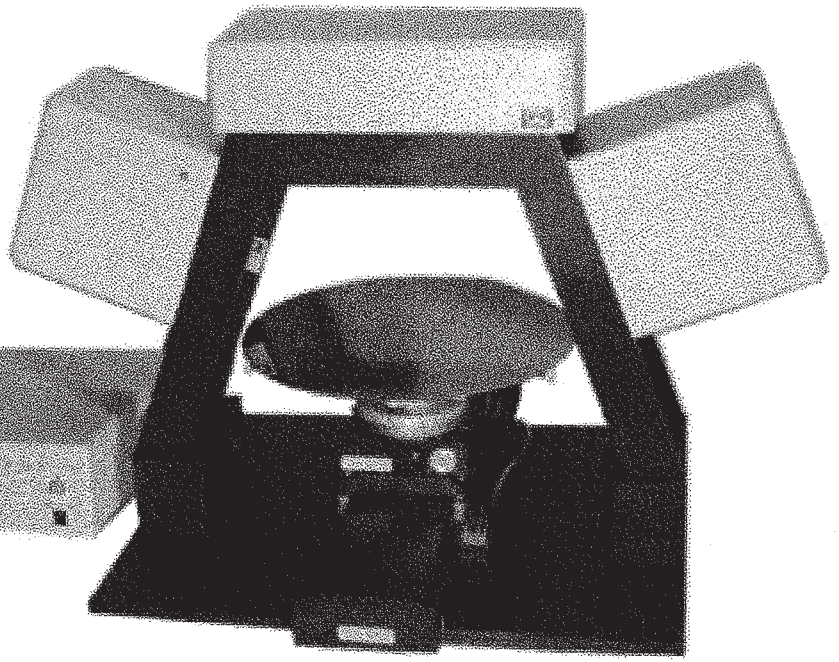
eclare that this Product complies with above directives and a CE-Mark is

999

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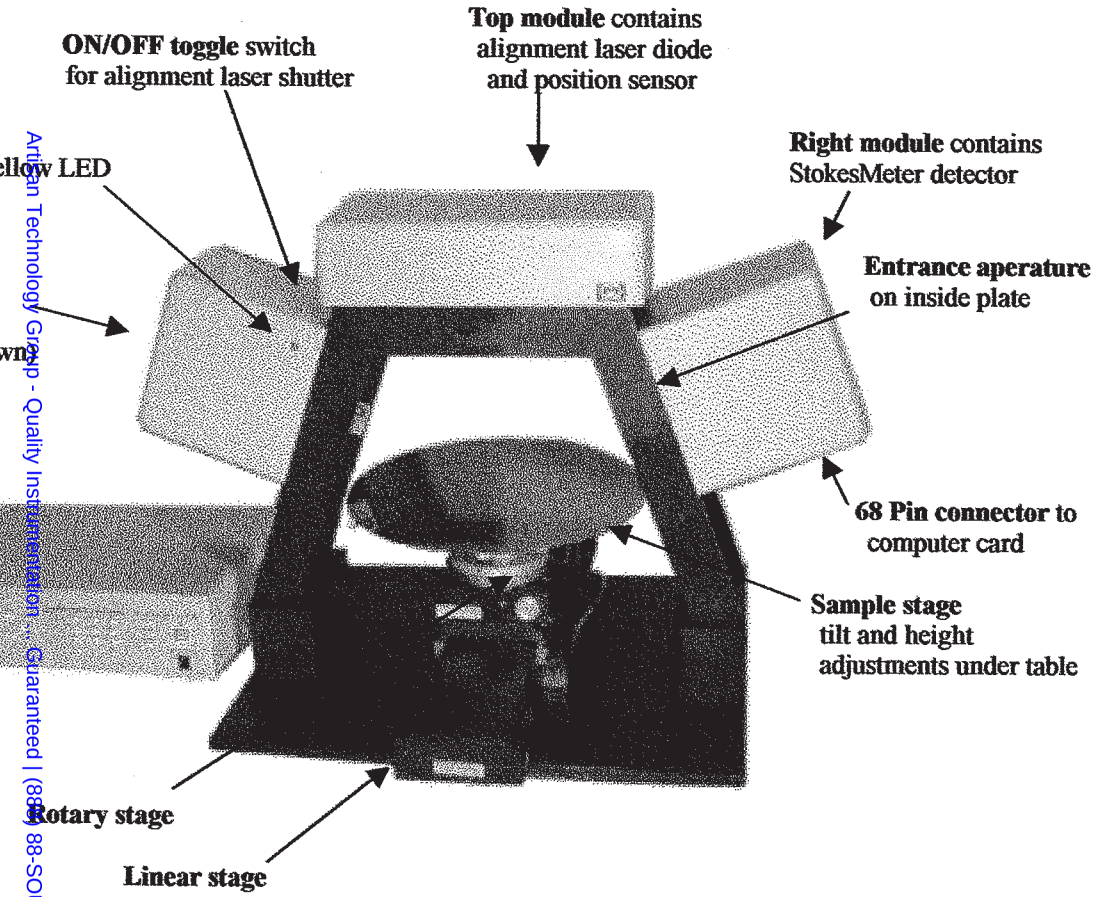
VS STOKES WAFERSKAN ELLIPSOMETER USER MANUAL

7109-C-352



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r Scientific Corporation
228 McCo nois 6007
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herScie



LSE-WS STOKES WAFERSKAN ELLIPSOMETER

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ontainer and the ellipsometer for shipping damage.
wafer, controller, 3 loose interface cables, laser power supply, user manual
and CDs were removed from the shipping container together with the
n to the computer equipment.

IDERATIONS

neter is designed for use in either a production or laboratory facility under
olled conditions providing relatively constant room ambient temperature at
ry, dust-free atmosphere. The ellipsometer requires a clean, solid, level
E-WS Ellipsometer alignment laser and StokesMeter detector is powered
face card that in turn is powered by the computer. The HeNe measuring
own separate key operated power supply. The line voltage to the
ree of transients having harmonics in the range from audio frequencies to
voltage surge protector is recommended for the system power.

ALLATION/ REINSTALLATION

for installing Waferskan software on a user supplied computer or should
sary on a Gaertner supplied computer.

E INSTALLATION

neter Measurement Program (GEMP) is for use with Windows 95, 98, Me,
puter monitor should be VGA with a minimum resolution of 600 x 800 in
ftware properly. To install the program on your hard drive follow these

ontaining the GEMP software in your floppy drive
menu, select RUN
d click OK
reate a directory \GSC on your hard drive
ompts to insert Disk #2 if necessary
stalled run the GEMP program by clicking on the program icon
ompts
button in the GEMP program toolbar for operating information
culation Mode found in this manual for an explaination of the calculation

E INSTALLATION

Software Driver on your computer using the supplied CD to enable
e A/D interface board. Allow the computer to reboot to complete the

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psometer interface card into your computer before the NI-DAQ been installed and the computer rebooted. If the interface card is -DAQ software driver is installed in the computer the card will be wn Plug-and-Play device with a yellow question mark in the device ter. If this is the case then delete this unknown device together with the ver, shutdown the computer, remove the card and reinstall the driver

nterface board or card is shipped in an anti-static conductive bag. Care re the board does not come in contact with any static electrical charges. nd of your computer before removing the card from the anti-static bag, and before touching the board. Try to handle the board by the edges, or by the l on the card; avoid touching the gold contacts.

ter power is turned off. Remove the computer cover. Remove the metal f an empty PCI slot in the PC. Make sure you save the screw for the next and again touch the metal ground of the computer chassis before allowing ntact any conductive parts of the computer. Install the card into any e slot. Make sure that the card is fully inserted and seated squarely. Screw or bracket using the slot cover screw. Replace the computer cover. Attach the interface card projecting from the back of the computer and tighten the he connector to the card. Attach the other end of the cable to the connector neter.

omputer the card should be automatically recognized by the computer. To Measurement and Automation Explorer. View Devices and interfaces and e shown.

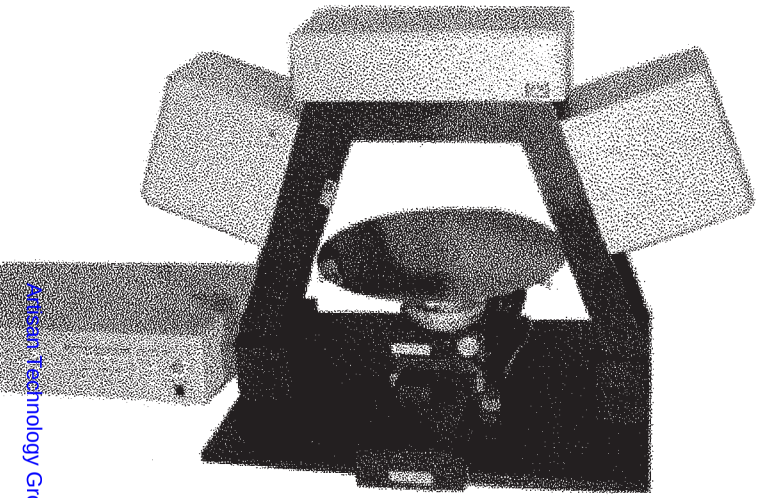
TWARE INSTALLATION

ftware Driver NI-488.2 on your computer using the supplied CD to enable he 24 pin GPIB interface board. Allow the computer to reboot to complete

RD INSTALLATION

psometer GPIB card into your computer before the GPIB software lled and the computer rebooted. See previous section on the NI-DAQ

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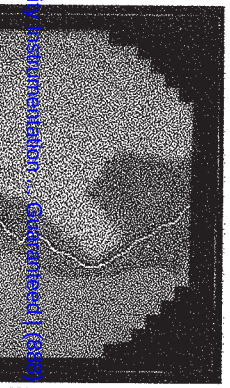
ands-off operation for similar wafers.
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g parts patented StokesMeter™ measurement head.
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changes. This permits fast, uninterrupted scanning over the entire wafer surface
o correct for focus and tilt. When scanning similar wafers, tilt-free, focus-free,
ndous speed is the obvious benefit.

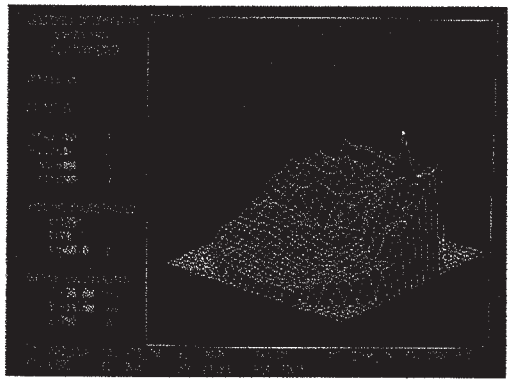
xides, nitrides and photoresists can be measured to sub-angstrom precision. Two, vith know bottom layers such as poly on oxide and oxide on poly on oxide can be and refractive index of the top layer or for both thicknesses. New Windows se.

easures by reflecting a polarized laser beam from the sample surface at a 70° es the change in polarization caused by the sample virtually instantaneously. Since the StokesMeter measuring head the measurements are accurate and repeatable continuous use. Precision of measurement is further enhanced by the use of a signal to noise HeNe laser light source.

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film thickness



3D contour map of film thickness

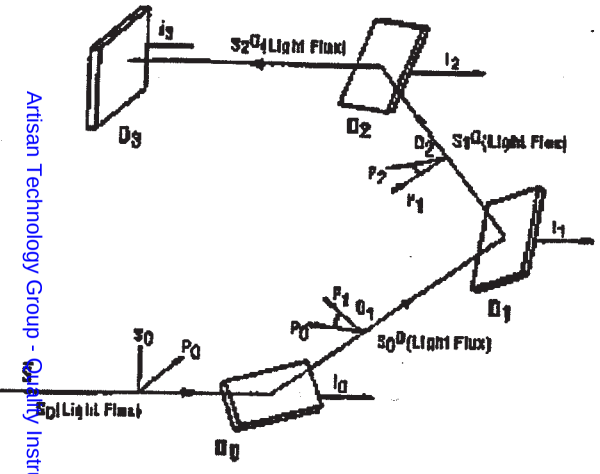
49 point measurement, diameter, X-Y, or Polar Scans with up to 1000 the wafer edge exclusion. The measurement results are displayed on the e sent to a printer. Results stored in a text data file are displayed in a 2D an be rotated, tilted, reduced or enlarged for immediate viewing and

stages provide precise and repeatable positions. The wafer is held on the . The stages move automatically in rapid yet precise steps under programmed nt time is less that one second per point including stage travel. Step precision

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state of the measuring beam.



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Abstract

simultaneous measurement of all four Stokes parameters of light. The
arization of which is to be determined, strikes, at oblique angles of
ctor surfaces in succession, each of which is partially spectrally
n generates an electrical signal proportional to the fraction of the
h photodetector is substantially totally light absorptive and detects
The four outputs thus developed form a 4x1 signal vector I which is
e input Stokes vector S. Consequently, S is obtained by S=A(-1)I. The
st be nonsingular, which requires that the planes of incidence for the
are all different. For a given arrangement of four detectors, A can
rmined by calibration.

eter replaces a typical rotating analyzer assembly consisting of a
ches, motor and detector and their associated electronics. In addition,
n the polarizer arm, is eliminated. This results in a fast, precise,
ometer.

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