KMS-310/400
Supervisor's Manual

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Contents

1 About This Manual

Intended Audience

This manual is written for users with a thorough understanding of measurement and inspection analysis concepts and terms.

This manual can be used by those unfamiliar with the KMS-310/400 system as a learning tool, and by experienced users as a reference.

The primary users of this manual are process engineers and senior-level fab technicians.

Manual Organization

This manual is organized into nine chapters:

- *Chapter 1: About this Manual* provides general information about this manual.
- *Chapter 2: Safety* provides general information about machine safety labels, safe system operation, caution and warning symbols, as well as anti-crash protection, light source safety and isopropyl alcohol and mercury lamp safety.
- *Chapter 3: System Overview* introduces the KMS-310/400 system and includes an overview of subsystem components, as well as a theory of operation for the measurement process.
- *Chapter 4:User Interface* provides an overview of supervisor-mode software organization and screen-level selections.
- *Chapter 5*: *System Setup* provides detailed instructions for system initialization, alignment of mechanical elements, as well as setup of the objectives, lamps, axes and LAN network.
- *Chapter 6*: *Script Creation* provides an overview of scripting terms and essential concepts, as well as an overview of the script creation process.
- *Chapter 7*: *Operation* provides a task overview and step-by-step procedures for setting up key system parameters, defining system options, measuring and managing measurement data.
- *Chapter 8*: *Maintenance* provides a preventive maintenance checklist and detailed procedures for each maintenance procedure called out in the PM checklist.
- *Chapter 9*: *Error Messages* provides a list of error messages for KMS-310/400 system software.

Conventions

Several conventions are used in this manual to emphasize special information, including:

- warnings and cautions
- tips, notes and cautions
- typographical and keyboard commands

Cautions

Special warnings and cautions to the reader are emphasized with the following convention:

Caution: This text can be used for machine/equipment cautions, as well as warnings. The only difference will be the first word; either caution or warning.

Tips

Special tips or notes to the reader are emphasized with the following convention:

Tip: This text can be used for special notes, examples or tips. The only difference will be the first word: which will read as note, tip or example.

Typographical and Keyboard Conventions

When you are instructed to enter specific information or press certain keys, the following conventions are used:

- Selections, commands, and field names are shown in *italics*.
- Text you are requested to enter is printed in `courier` type.
- Keys you press on the keyboard are shown in brackets, such as [ESC], [ENTER] or [space bar].
- Issuing commands by holding down the first key and pressing the second key are shown as [key1] + [key2], such as [ALT] + [PRINTSCRN].

Contacting Technical Support

For technical assistance, contact your Zygo Service or Applications Engineer at (408) 434-1000.

For information on your system options, or to purchase additional options or site licenses, contact your Zygo Sales Representative or Zygo Corporate Sales.

2 Safety Precautions

Machine Safety Labels

Objective Anti-Crash Protection

Light Source Safety

Isopropyl Alcohol Safety

Mercury Safety

Machine Ergonomic Features

Machine Safety Labels

This section provides a general explanation of the different warning and caution labels used on the KMS-310/400 system, as well as a description and location for each specific warning and caution label on the system.

Important note: Read the operating instructions carefully and completely before operating the KMS-310/400 system. All warnings and cautions in this manual and on the system should be strictly followed.

Caution and Warning Symbols

Table 2-1 lists the caution and warning symbols used throughout the KMS-310/400 system and provides a general description for each label.

Table 2-1. Caution and Warning Symbols (1 of 2)

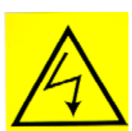
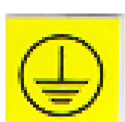
Symbol	Type of Warning	Description
	Operation warnings and cautions	Alerts you to important operating and maintenance instructions provided in this manual.
	Dangerous voltage warning	Alerts you to the presence of uninsulated dangerous voltage in the KMS-310/400 enclosure. This label indicates dangerous voltage of a sufficient magnitude to constitute risk of electric shock to persons.
	Protective conductor warning	Alerts you to the presence of a protective conductor terminal (protective earth ground).
	Pinch point warning	Alerts you to a potential pinch-point in this area.
	Hot surface warning	Alerts you of a potential hot surface on a lamphouse. Always allow the lamphouse to cool for at least 20 minutes before handling.

Table 2-1. Caution and Warning Symbols (2 of 2)

Symbol	Type of Warning	Description
	Infrared radiation hazard warning	Alerts you to a potential infrared radiation hazard. Never remove a lamphouse or disconnect fiber optics while the lamp is on. Never stare directly into the beam path of any system light source.
	Ultraviolet radiation warning	Alerts you to a potential ultraviolet radiation hazard. Never remove a lamphouse or disconnect fiber optics while a lamp is on. Never stare directly into the beam path of any system light source.

Safety Label Locations

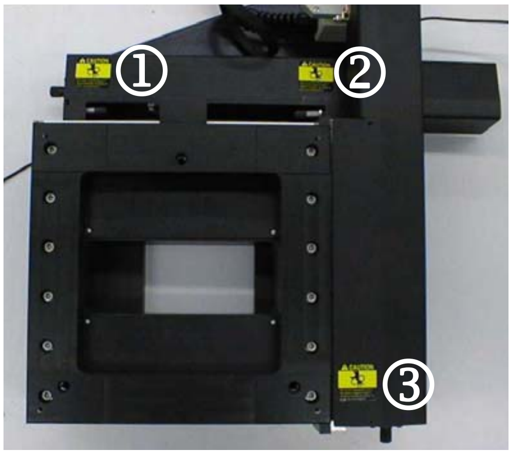
This section provides a location and detailed explanation for each caution and warning label on the KMS-310/400, including those found on the:

- automated stage
- halogen transmitted light source
- Hg-Xe power supply
- mercury or xenon lamphouse
- metal halide lamphouse and power supply
- K2 coupler
- electronics tower (back, sides and inside bottom)
- transparent electrical shock guard

Automated Stage Safety Labels

The automated stage warning labels are shown in Figure 2-1.

Figure 2-1. Automated Stage Warning Labels



① Alerts you to a potential pinch-point in this area.

② Alerts you to a potential pinch-point in this area.

③ Alerts you to a potential pinch-point in this area.

Halogen Transmitted Light Source Safety Labels

The halogen transmitted light source safety labels, located on the front and top of the unit, are shown in Figures 2-2 and 2-3.

Figure 2-2. Halogen Transmitted Light Source Safety Label (Top)

① Alerts you to a potential hot surface on the lamphouse.

Always allow the lamphouse to cool for at least 20 minutes before handling.

Figure 2-3. Halogen Transmitted Light Source Safety Label (Front)

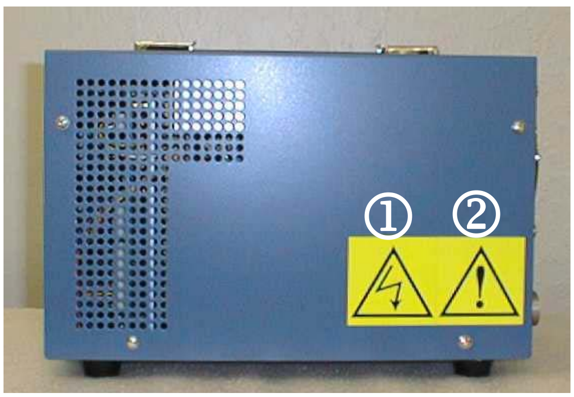
① Alerts you to a potential infrared radiation hazard.

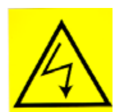
Never remove a lamphouse or disconnect fiber optics while the lamp is on. Never stare directly into the beam path of any system light source.

Hg-Xe Power Supply Safety Labels

The Hamamatsu Hg-Xe power supply safety label is shown in Figures 2-4.

Figure 2-4. Hamamatsu Hg-Xe Power Supply Safety Label





① Never turn on the power if the lamp is not installed. If you do, you are in danger of being electrocuted.

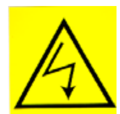
② Make sure the light source power supplies are turned off before replacing the lamp.

Mercury Xenon Lamphouse Safety Labels

The KLH-1 mercury xenon lamphouse safety labels, located on the main lamphouse and fiber-optic units, are shown in Figures 2-5 and 2-6.

Figure 2-5. Mercury Xenon Lamphouse Safety Labels (Main Lamphouse Unit)

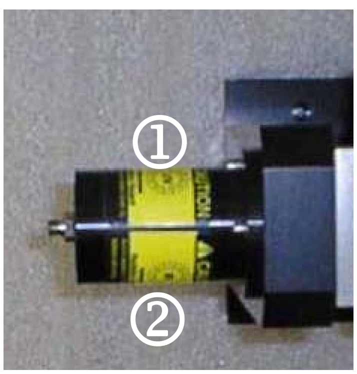
① Make sure light source power supplies are turned off before attempting to replace the lamp.



② Make sure light source power supplies are turned off before attempting to replace the lamp.

Never turn on the power if the lamp is not installed. If you do, you are in danger of being electrocuted.

Figure 2-6. Mercury Xenon Lamphouse Safety Labels (Fiber Optics Unit)



① Make sure light source power supplies are turned off before attempting to replace the lamp.

② Alerts you of a potential infrared radiation hazard. Never remove a lamphouse or disconnect fiber optics while the lamp is on. Never stare directly into the beam path of any system light source.

Metal Halide Lamphouse and Power Supply Safety Labels

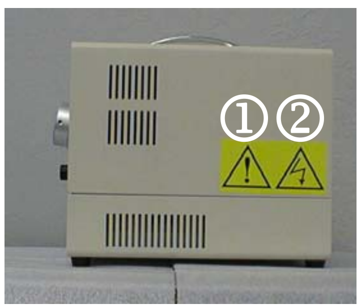
The Nikon metal halide lamphouse and power supply safety labels, located on the front and side of the main lamphouse, are shown in Figures 2-7 and 2-8.

Figure 2-7 Metal Halide Lamphouse and Power Supply Safety Labels (Front)

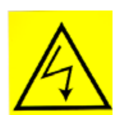
① Alerts you to a potential infrared radiation hazard. Never remove a lamphouse or disconnect fiber optics while the lamp is on. Never stare directly into the beam path of any system light source.

② Alerts you to the potential hazard of ultraviolet radiation. Never remove the lamphouse or disconnect fiber optics while the lamp is turned on. Do not stare directly into the beam path of any light source.

Figure 2-8. Metal Halide Lamphouse and Power Supply Safety Labels (Side)



① Refer to the KMS-310/400 Maintenance Manual before servicing.

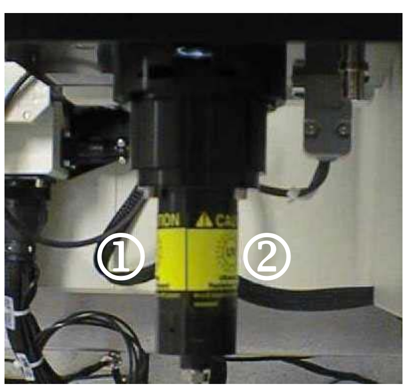


② Uninsulated dangerous voltage within the lamphouse enclosure posing a risk of electric shock. Never open the lamphouse enclosure while lamp power is on.

K2 Coupler Safety Label

The K2 coupler safety labels are shown in Figure 2-9.

Figure 2-9. K2 Coupler Safety Label



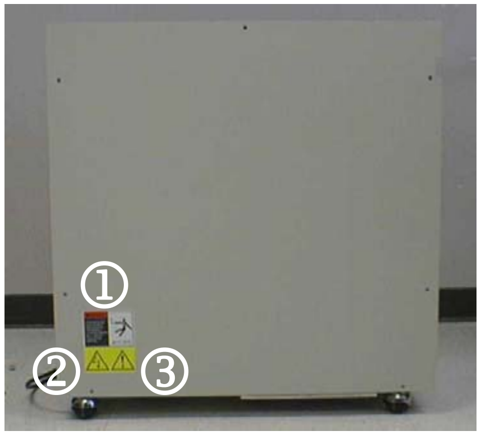
① Alerts you to a potential infrared radiation hazard. Never remove a lamphouse or disconnect fiber optics while the lamp is on. Never stare directly into the beam path of any system light source.

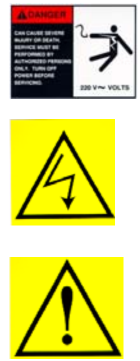
② Alerts you to the potential hazard of ultraviolet radiation. Never remove the lamphouse or disconnect fiber optics while the lamp is turned on. Do not stare directly into the beam path of any light source.

Electronics Tower Safety Labels

The electronics tower safety labels, located on the sides, back and inside bottom, are shown in Figures 2-10 through 2-12.

Figure 2-10. Electronics Tower Safety Labels (Sides)



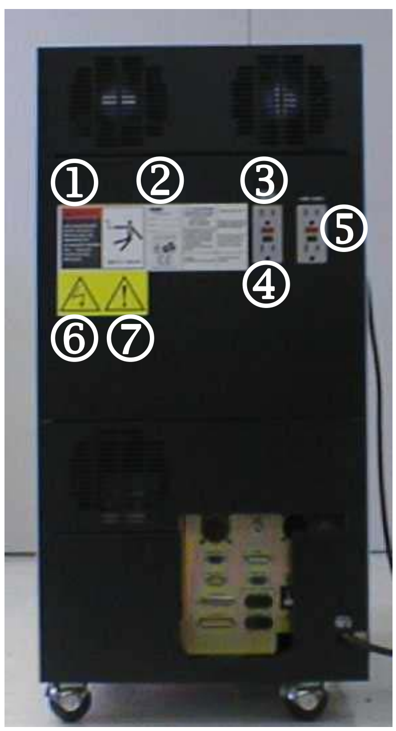


① This symbol alerts you to the presence of 220VAC within the tower enclosure.

② Uninsulated dangerous voltage within the lamphouse enclosure poses a risk of electric shock.

③ Refer to the KMS-310/400 Maintenance Manual before servicing.

Figure 2-11. Electronics Tower Safety Labels (Back)



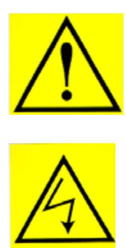
① This symbol alerts you to the presence of 220VAC within the tower enclosure.

② This sticker alerts you to the presence of dangerous voltages inside the tower, which pose the risk of electrical shock.

③ This receptacle is for use with system options only.

④ This receptacle is for use with the system monitor only.

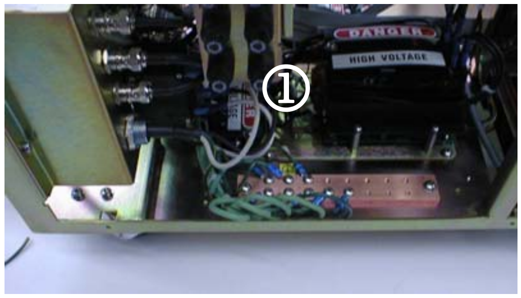
⑤ These receptacles are for use with lamp units only.

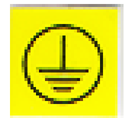


⑥ Refer to the KMS-310/400 Maintenance Manual before servicing.

⑦ Uninsulated dangerous voltage within the lamphouse enclosure posing a risk of electric shock.

Figure 2-12. Electronics Tower Safety Labels (Inside Bottom)



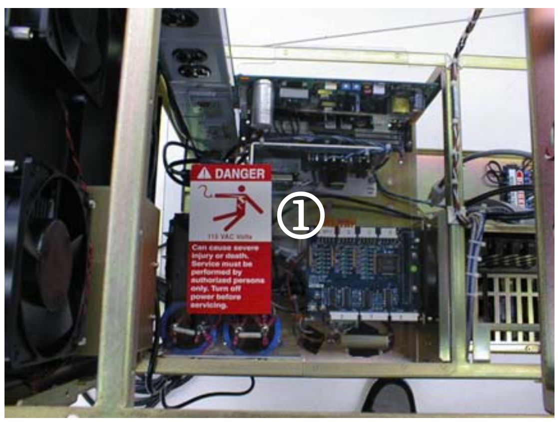


① Alerts you to the presence of a protective conductor terminal (protective earth ground).

Transparent Electrical Shock Guard Safety Label

The transparent electrical shock guard safety label is shown in Figure 2-13.

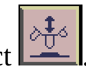
Figure 2-13. Transparent Electrical Shock Guard Safety Label



① Alerts you to the presence of 115VAC within the unit enclosure. (The clear plastic shield in front of this warning is intended to protect you from accidental electrical shock.)

Objective Anti-Crash Protection

To avoid crashing an objective on the KMS-310/400 system, perform the following procedure during initial system setup or after performing preventive maintenance:

1. With the main menu displayed, select .
2. Use the 100X or 50X magnification objective to focus on the highest (upmost) feature of the image.
3. With the image in focus, note the Z-axis scale reading (in microns).
4. Use the  key to drive the objective 100 microns closer to the image.

   For example, the Z-axis scale readings should increase by 100 microns.
5. Use the thumbwheel (on the side of the column) to move the Z-axis limit switch until the red LED on the side of the column illuminates.

   The Z-axis lower limit switch is now set.
6. Refocus the 10X objective.

Light Source Safety

This section provides safety information for the following KMS-310/400 light sources:

- mercury xenon lamphouse
- halogen light box
- metal halide light box
- halogen lamphouse
- mercury lamphouse
- xenon lamphouse

Mercury Xenon Lamphouse

The KLH-1 mercury xenon lamphouse is equipped with a safety interlock feature. When the lamphouse is opened, the power circuit loop is placed in an open state and no power will reach the lamp. The lamp will not turn on while the lamphouse is open.

Take the following precautions when working in and around the mercury xenon lamphouse:

1. Never open the lamphouse when the lamp is turned on.
2. Use a hex wrench to remove the KLH-1 lamphouse from its lamp stand. This will prevent unnecessary access and IR/UV exposure.
3. Use a wrench to remove the fiber optic (attached to the optical adapter on the lamp stand). This will prevent unnecessary access and IR/UV exposure.
4. Never stare into the light source.

Halogen Light Box

The halogen light box is equipped with a safety interlock feature. When the light box is opened, the power circuit loop is placed in an open state and no power will reach the lamp. The lamp will not turn on while the light box is open.

Take the following precautions when working in and around the halogen light box:

1. Never open the light box when the lamp is on.
2. Use a hex wrench to remove the liquid light guide (attached to the halogen light box). This feature helps prevent unnecessary access and IR/UV exposure.
3. Never stare into the light source.

Metal Halide Light Box

The metal halide light box is equipped with a safety interlock feature. When the light box is opened, the power circuit loop is placed into an open state and no power reaches the lamp. The lamp will not turn while the light box is open.

Take the following precautions when working in and around the metal halide light box:

1. Never open the light box when the lamp is on.
2. Use a hex wrench to remove the liquid light guide (attached to the metal halide light box). This feature helps prevent unnecessary access and IR/UV exposure.
3. Never stare into the light source.

Halogen Lamphouse

Use a hex wrench to remove the HMX-2 halogen lamphouse from the EPI illuminator. This feature helps prevent unnecessary access and IR/UV exposure.

Mercury Lamphouse

Take the following precautions when working in and around the mercury lamphouse:

1. Use a hex wrench to remove the HMX-4 mercury lamphouse from the K2 module. This feature helps prevent unnecessary access and IR/UV exposure.
2. Never stare into the light source.

Xenon Lamphouse

Take the following precautions when working in and around the xenon lamphouse:

1. Use a hex wrench to remove the HMX-4 xenon lamphouse from the K2 module. This feature helps prevent unnecessary access and IR/UV.
2. Never stare into the light source.

Isopropyl Alcohol Safety

This section outlines potential hazards associated with the use of isopropyl alcohol, as well as emergency response procedures for public safety, evacuation, fire, spills and leaks, and first aid.

Potential Hazards

Potential hazards associated with isopropyl alcohol are shown in Table 2-2. This information comes from *The Department of Transportation Guide #129*.

Table 2-2. Potential Hazards with Isopropyl Alcohol

Hazard Type	Potential Hazards
Health	▪ May cause toxic effects if inhaled or absorbed through skin. ▪ Inhalation or contact with material may irritate or burn skin and eyes. ▪ Fire will produce irritating, corrosive and/or toxic gases. ▪ Vapors may cause dizziness or suffocation. ▪ Runoff from fire control or dilution water may cause pollution.
Fire or Explosion	▪ Highly flammable; easily ignited by heat, sparks or flames. ▪ Vapors may form explosive mixtures with air. ▪ Vapors may travel to source of ignition and flash back. ▪ Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (such sewers, basements, and tanks). ▪ Vapor explosion hazard indoors, outdoors or in sewers. ▪ Some may polymerize (P) explosively when heated or involved in a fire. ▪ Runoff to sewer may create fire or explosion hazard. ▪ Containers may explode when heated. ▪ Many liquids are lighter than water.

Emergency Response

Emergency response procedures to be taken in the case of an isopropyl alcohol-related accident are shown in Table 2-3. This information comes from *The Department of Transportation Guide #129*.

Table 2-3. Emergency Response Procedures for Isopropyl Alcohol-Related Accidents (Part 1 of 2)

Type	Emergency Response Guidelines
Public safety	▪ Call the emergency response telephone number on the shipping paper first. If the shipping papers not available, or if there is no answer when you call the number, refer to the appropriate telephone number listed on the inside back cover. ▪ Isolate the spill or leak area immediately for at least 50 to 100 meters (160 to 330 feet) in all directions. ▪ Keep unauthorized personnel away. ▪ Stay upwind. ▪ Keep out of low areas. ▪ Ventilate closed spaces before entering.
Protective clothing	▪ Wear a positive pressure self-contained breathing apparatus (SCBA). ▪ Structural firefighters' protective clothing will only provide limited protection.
Evacuation	▪ If it is a large spill, consider initial downwind evacuation for at least 300 meters (1000 feet). ▪ If a tank, rail car or tank truck is involved in a fire, isolate for 800 meters (1/2 mile) in all directions. Also, consider initial evacuation for 800 meters (1/2 mile) in all directions.
Small fires	▪ Isopropyl alcohol products have a very low flash point: Use of water spray when fighting fire may be inefficient. Use dry chemical, CO_2, water spray or alcohol-resistant foam to fight fire. ▪ Do not use dry chemical extinguishers to control fires involving nitromethane or nitroethane.
Large fires	▪ Isopropyl alcohol products have a very low flash point: Use of water spray when fighting fire may be inefficient. ▪ Use water spray, fog or alcohol-resistant foam to fight fire. ▪ Do not use straight streams. ▪ Move containers from fire area if you can do it without risk.
Fire involving tanks or car/trailer loads	▪ Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. ▪ Cool containers with flooding quantities of water until well after fire is out. ▪ Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ▪ Always stay away from the ends of tanks. ▪ For massive fire, use unmanned hose holders or monitor nozzles. If impossible, withdraw from area and let fire burn.

Table 2-3. Emergency Response Procedures for Isopropyl Alcohol-Related Accidents (Part 2 of 2)

Type	Emergency Response Guidelines
Small spills or leaks	▪ Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). ▪ All equipment used when handling the product must be grounded. ▪ Do not touch or walk through spilled material. ▪ Stop leak if you can do it without risk. ▪ Prevent entry into waterways, sewers, basements or confined areas. ▪ A vapor suppressing foam may be used to reduce vapors. ▪ Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. ▪ Use clean non-sparking tools to collect absorbed material.
Large spills	▪ Dike far ahead of liquid spill for later disposal. ▪ Water spray may reduce vapor; but may not prevent ignition in closed spaces.
First aid	▪ Move victim to fresh air. ▪ Call emergency medical care. ▪ Apply artificial respiration if victim is not breathing. ▪ Administer oxygen if breathing is difficult. ▪ Remove and isolate contaminated clothing and shoes. ▪ In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. ▪ Wash skin with soap and water. ▪ Keep victim warm and quiet. ▪ Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. ▪ Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Mercury Safety

This section outlines potential hazards associated with the use of mercury, as well as emergency response procedures for public safety, evacuation, fire, spills and leaks, and first aid.

Potential Hazards

Potential hazards associated with mercury are shown in Table 2-4. This information comes from *The Department of Transportation Guide #172*.

Table 2-4. Potential Hazards with Mercury

Hazard Type	Potential Hazards
Health	Inhalation of vapors or contact with substance will result in contamination and potential harmful effects. Fire will produce irritating, corrosive and/or toxic gases.
Fire or explosion	Mercury is itself a noncombustible that does not burn. However, if heated, it may react to produce: ▪ Corrosive and/or toxic fumes. ▪ Runoff that may pollute waterways.

Emergency Response

Emergency response procedures to be taken in the case of an mercury-related accident are shown in Table 2-5. This information comes from *The Department of Transportation Guide #172*.

Table 2-5. Emergency Response Procedures for Mercury-Related Accidents (Part 1 of 2)

Type	Emergency Response Guidelines
Public Safety	▪ Call the emergency response telephone number on the shipping paper first. If the shipping paper is not available, or if there is no answer when you call the number, refer to the appropriate telephone number listed on the inside back cover. ▪ Isolate the spill or leak area immediately for at least 10 to 25 meters (30 to 80 feet) in all directions. ▪ Keep unauthorized personnel away. ▪ Stay upwind.
Protective clothing	▪ Wear positive pressure self-contained breathing apparatus (SCBA). ▪ Structural firefighters' protective clothing will only provide limited protection.
Evacuation	▪ If it is a large spill, consider initial down wind evacuation for at least 100 meters (330feet). ▪ When any large container is involved in a fire, consider initial evacuation for 500 meters (1/3 mile) in all directions.
Fire	▪ Use extinguishing agent suitable for type of surrounding fire. ▪ Do not direct water at the heated metal.

Table 2-5. Emergency Response Procedures for Mercury-Related Accidents (Part 2 of 2)

Type	Emergency Response Guidelines
Spill or leak	▪ Do not touch or walk through spilled material. ▪ Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. ▪ Stop leak if you can do it without risk. ▪ Prevent entry into waterways, sewers, basements or confined areas. ▪ Do not use steel or aluminum tools or equipment. ▪ Cover with earth, sand, or other noncombustible material followed with plastic sheet to minimize spreading or contact with rain. ▪ For mercury, use a mercury spill kit. ▪ Mercury spill areas may be subsequently treated with a calcium sulphide/calcium sulfide or sodium thiosulphate/sodium thiosulfate wash to neutralize any residual mercury.
First aid	▪ Move victim to fresh air. ▪ Call emergency medical care. ▪ Apply artificial respiration if victim is not breathing. ▪ Administer oxygen if breathing is difficult. ▪ Remove and isolate contaminated clothing and shoes. ▪ In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. ▪ Keep victim warm and quiet. ▪ Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

Machine Ergonomic Features

Table 2-6 lists ergonomic features for key KMS-310/400 components.

Table 2-6. KMS-310/400 Ergonomic Features

KMS-310/400 Component	Ergonomic Features
Adjustable monitor	▪ Monitor arm lifts base of monitor 8"-13.25" above the table top. ▪ Monitor arm extends and retracts 10.25". ▪ Monitor arm rotates laterally across an 180^0 range. ▪ Monitor tilts up or down across a 17^0 range. ▪ Monitor swivels laterally across a 100^0 range. ▪ 17" display. ▪ 0.22mm dot pitch. ▪ Low ELF and VLF emission for operator safety to MPR II standards. ▪ Easy to use on-screen menu. ▪ 130-Hz maximum refresh rate.
Keypad	▪ Comes with a 9.5' cord.
Keyboard	▪ Comes with a 2.75' cord.
Other system components	▪ EMO button is colored for easy visibility and positioned for easy accessibility. ▪ Optimal trinocular height of 4.75'. ▪ Optimal machine loading height of 3.5'.

3 System Overview

Product Overview

The KMS-310/400 Critical Dimension Measurement and Inspection System (Figure 3-1) is a completely automated pattern recognition and measurement system. The combination of high-resolution capabilities, a confocal microscope with a shallow depth of focus, and pattern recognition routines allow for easy capture of optical images for measurement. These images can be used for precise inspection and measurement of the selected feature and for solving a variety of measurement and inspection problems.

Figure 3-1. KMS-310/400 System Critical Dimension Measurement and Inspection System

The KMS-310/400 system is a completely automated measuring system. It consists of measurement electronics, a confocal optics module, and a computer-controlled programmable 8" x 8" stage with automatic Piezo-controlled focus. The KMS-310/400 system can locate previously programmed features under a high-magnification objective to within 2-5 microns (depending on your system's configuration) and can measure depth differences in the Z-axis to a 3 sigma value of 0.03 microns.

Script Routines

Script routines allow you to automate control of physical, hardware and user-programmed software components of the KMS-310/400. Individual scripts can be written and stored for use by fab operators. By creating a script, you can create an automated solution to many, if not all, types of measurement problems that can be imaged within the microscope optics.

Product Applications

The KMS-310/400 can be used to measure the geometry edge features on:

- semiconductor photomasks
- thin film magnetic heads
- metal-in-gap magnetic heads
- standard heads
- wafers
- other types of measurements

System Configurations

The KMS-310/400 can be purchased in any of the following configurations:

- KMS-310
- KMS-400

The KMS-310 is configured with a:

- square pixel camera with an interline/interlaced transfer method for image gathering
- Matrox frame grabber card and card-specific algorithm

The KMS-400 is configured with a:

- new camera that uses interline transfer of pixel information and a progressive interlacing method (allowing adjustment of the camera's shutter and gain in addition to analog gain, gain and offset)
- micro lens over each pixel to increase the camera's fill factor
- Matrox frame grabber card and card-specific algorithm

Frame Grabber

Software controlled, the frame grabber performs measurements and pattern recognition routines. The frame grabber can also overlay both video- and computer-generated graphics on top of captured images.

Script software can be used to make multiple measurements in both the X- and Y-axis with one frame of information. This information can then be used to take Z-axis measurements at each X- and Y-axis measurement position. Single frames of information can be expanded up to an average of 32 frames per second.

Data Output

The KMS-310/400 can output data to a:

- hard disk in multiple file formats
- external printer
- PC-compatible network

Subsystem Overview

The KMS-310/400 consists of the following subsystems:

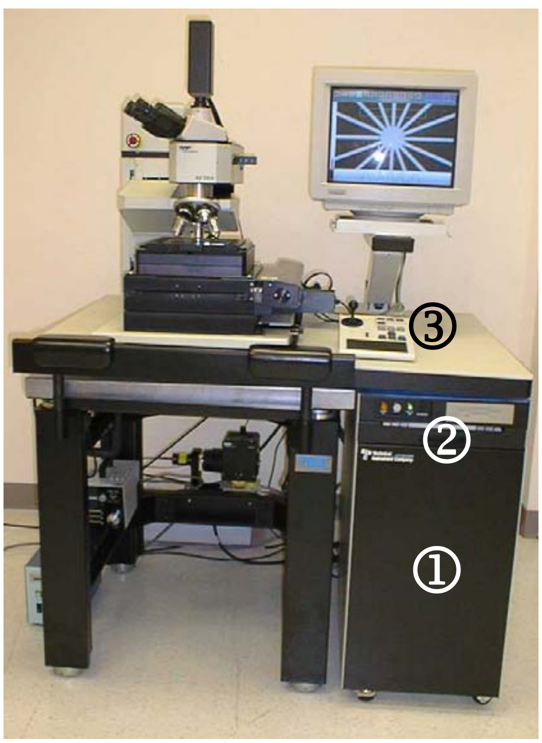
- electronic controls subsystem
- optical display subsystem
- mechanical subsystem

Electronic Measurement Subsystem

The electronic measurement subsystem (Figure 3-2) consists of:

- an electronics control unit
- a power control panel
- computer system and controls
- software

Figure 3-2. KMS-310/400 Electronics Subsystem Components



① electronics control unit

② power control panel

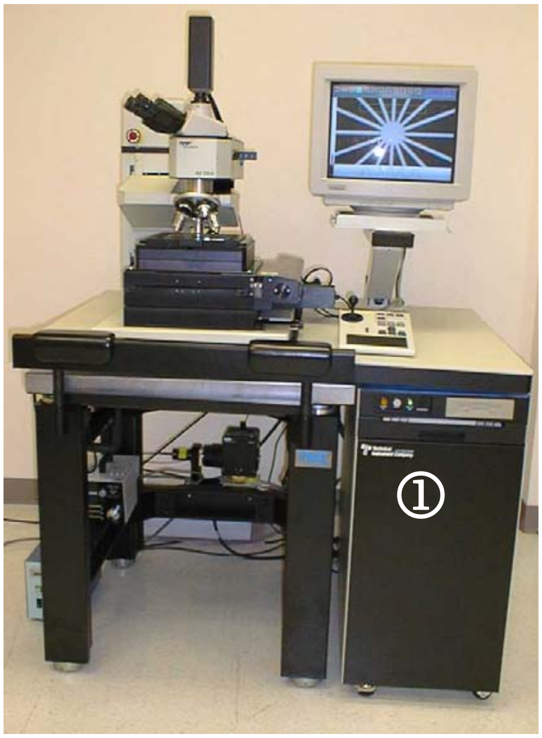
③ computer system controls

Electronics Control Unit

All electronic and electrical controls for the KMS-310/400 system are located in the electronics control unit (Figure 3-3), including:

- system power supply (CE marked)
- AC power terminal block and sequencer
- X-Y-Z motion control unit
- rotary-encoded power control unit;
- turret control card
- Piezo control assembly
- camera control unit
- video frame grabber card;
- KMS-310/400 control card
- local area network (LAN) card (standard or model 400);
- cooling assemblies

Figure 3-3. Electronics Control Unit



① electronics control unit

The standard system is configured for a supply voltage of 230 VAC (grounded single-phase) at a500 VA.

Two switched outlets and two 115 VAC outlets are located on the back panel of the electronics control unit. The switched outlets are used for system components, such as the monitor or illumination power supplies. The AC outlets are not switched for system components. All of these outlets are deactivated whenever the emergency off (EMO) button is pushed.

The Piezo control assembly is used to fine focus a substrate to an objective by moving the substrate toward or away from the objective in increments of 0.01-0.02 microns. Moving the thumbwheel on the keypad up will move the substrate closer to the objective, and moving it down will move the substrate away from the objective.

The Piezo control assembly should be kept at the center of its range ±15 microns for transmitted light systems (±10 microns for reflected or confocal light systems) until you are approximately in focus with the column (coarse) focus. Once you have completed coarse focus, you can move the Piezo to find the desired feature and perform autofocus.

Power Control Panel

The power control panel is located in the front of the electronics cabinet (Figure 3-4). Functions for each of the control panel components are listed in Table 3-1.

Figure 3-4. Power Control Panel

① power on switch

② reset switch

③ power off switch

④ keyboard connector

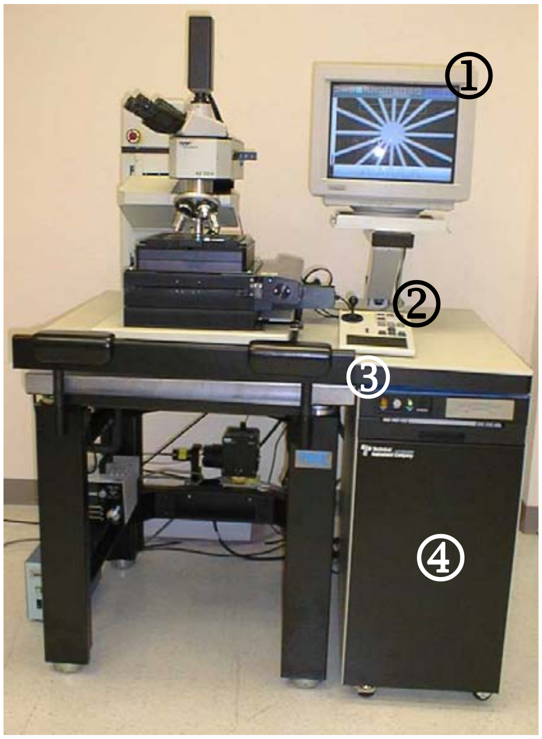
Table 3-1. Power Control Panel Component Functions

Figure Callout	Component	Function
①	Power On Switch	This switch is the master control switch for the entire system. It controls power to all subsystems within the KMS-310/400 system. (The lamp power supply must be turned on separately before applying power to the system.)
②	Reset switch	This switch resets the entire system and reboots the computer. When this switch is activated, you will need to reinitialize the stage and program operations.
③	Power Off switch	When this switch is pressed, all power to the system is removed. (Power to the lamps is still on.)
④	Keyboard connector	This connector allows you to connect a keyboard to the system, which you can use in place of or in addition to the standard keypad.

Computer System and Controls

The computer system and control components (Figure 3-5) include a DOS-compatible 80486 computer, VGA monitor, keypad and keyboard (optional).

Figure 3-5. Computer System and Controls



① monitor

② keypad

③ keyboard

④ computer

As a minimal configuration, the KMS-310/400 DOS-compatible computer includes:

- 80486 motherboard
- 800 MB - 2.0 GB hard drive
- 8 MB random access memory (RAM)
- one 3.5" 1.44-MB floppy disk drive
- 16K internal cache memory
- external 256K high-speed SRAM cache memory (expandable to 1M)
- Weitek 4167 numeric coprocessor socket
- seven 16 bit and one 32 bit AT-compatible expansion slots
- LIM EMS 4.0 support
- one serial and one parallel communication ports
- onboard battery
- eight motherboard expansion slots (five are used for KMS-310/400 system control)

PC boards included in the standard configuration include:

- KMS control board (part no. 260-00032-03)
- Galil motor motion control card (part no. 270-00010-00)
- video control card (part no. 270-00014-00)
- serial parallel I/O card (part no. 270-00006-01)
- disk control card (part no. 270-00013-00)
- three unused expansion slots for you custom installation, such as a network card

The 17 in. diagonal, 640 x 480 pixels SVGA color monitor operates in VGA mode. The VGA standard display controller features RS-170 realtime video input capability with VGA overlay on a single card for DOS-compatible computers. Video images from the microscope and the graphical user interface are displayed on the monitor at 60 Hz in a noninterlaced flicker format.

The keypad is the primary means of operating the KMS-310/400 system, from program setup to stage positioning and measurement. Only alphanumeric entries cannot be made with the keypad. It consists of 11 dedicated keys, a single 2-axis joystick, and rotary thumbwheel.

The KMS-310/400 system also has a drawer-mounted keyboard, located in the electronics control unit. This permanently attached keyboard is a standard full-function keyboard with a reduced size. You can use it in place of the keypad for all system functions, or only use it to type alphanumeric and DOS entries.

Software

The KMS-310/400 system provides a graphical user interface (GUI) for control of all computer functions. The software's menus are layered over live video from the microscope on the VGA monitor.

KMS KMS-310/400 system can be operated in either Supervisor or Production mode. Supervisor mode allows users with a password to set up measurement routines and configure system parameters. Production mode provides a streamlined interface for routine measurement operations.

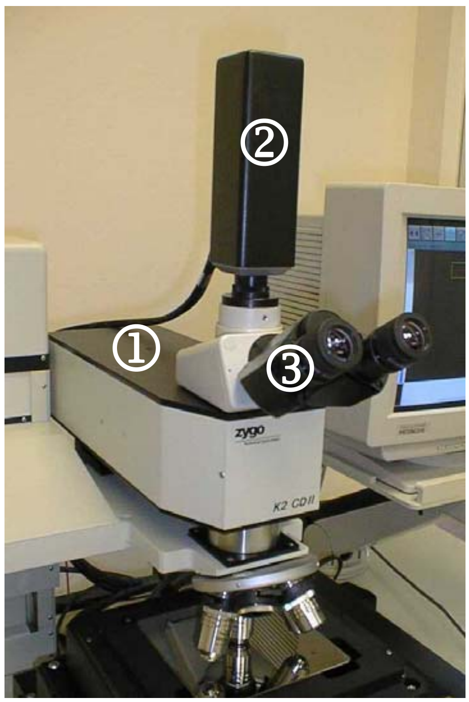
The KMS 310 is controlled by software version 310_300 (or greater). The KMS 400 is controlled by software version 400_427 (or greater).

Optical Display Subsystem

The optical display subsystem (Figure 3-6) consists of:

- a confocal optics module
- a charged coupled device (CCD) camera and frame grabber
- microscope optics
- illumination hardware

Figure 3-6. Optical Display Subsystem



① confocal optics module

② camera and frame grabber

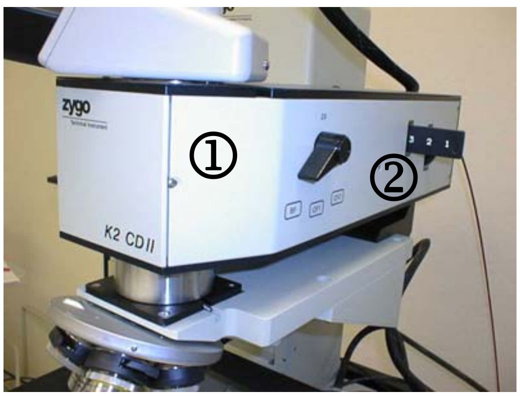
③ microscope optics

Confocal Optics Module

The confocal optics module (Figure 3-7) contains a spinning Nipkow disk (with two sizes of pinholes) and a manual lever for switching between the brightfield, confocal 1, and confocal 2 positions. For brightfield operation with transmitted light applications, the Nipkow disk is moved out of the optical path, yielding a conventional microscope.

Note: The confocal optics module (on KMS 310R and KMS 310RT systems) replaces the vertical illuminator used on standard microscopes. The confocal module has three modes of operation; brightfield, confocal 1 and confocal 2.

Figure 3-7. Confocal Optics Module



① confocal optics module

② manual lever

Rotate the trinocular head to control the confocal optics module. The trinocular head contains two standard binocular eyepieces and a third optional port for the CCD camera. To look through the binoculars, rotate the head assembly to bring the oculars to the front of the system. When you rotate the head assembly, the VGA display will turn black. To view an image for measurement, rotate the oculars 45 degrees to the left (facing the front of the system).

Use the filter wheel to select the type of filter you want to use. Position 1 will open the trinocular head. Positions 2-5 will select successively higher absorptive neutral density filters.

Use the aperture slider to adjust the opening of the aperture. Position 1 will select the smallest aperture and should only be used for high magnification objectives. Positions 2-5 will set the aperture to increasingly larger apertures and should be used for measurement and lower magnification settings.

Note: Unless otherwise recommended, use the #3 setting for the aperture.

KMS models 310 and 400 include a Nipkow disk lever. The Nipkow disk lever has three settings: confocal 2, confocal 1 and brightfield. The confocal 2 setting uses 25 micron pinholes. This setting provides the shallowest depth of focus and greatest contrast (with the least amount of light available. The confocal 1 setting uses 45 micron pinholes. This setting provides a greater amount of light and a slightly larger depth of focus than the confocal 2 setting. The brightfield setting moves the Nipkow disk out of the light source path for transmitted illumination mode or brightfield reflected illumination mode. In its place, a neutral density filter is placed in the light source path to protect you from eye injury.

Charged Coupled Device (CCD) Camera and Frame Grabber

The CCD camera is mounted on the trinocular viewing port of the microscope (Figure 3-8). The CCD camera captures images for measurement at the rate of approximately 300,000 pixels, or picture elements, in 1/30 of a second. Each of these pixels is assigned an illumination value between 0-256, based on an 8 bit data capture and output methodology.

Figure 3-8. CCD Camera

① CCD camera

Once the images are captured, they are processed and output to the VGA monitor by a frame grabber board. Each captured image is transferred from the camera to the VGA monitor in a series of gray scale values that can be used for image processing. The exact value assigned to each pixel depends on the size of the charge from the CCD camera. A brighter image may be assigned a value of 200 (with a maximum value of 255) while a darker image may be assigned a value of 40 (with a minimum value of 0). Each frame of information that is gathered by the frame grabber board is summed to the preceding frame by the value you assign during program setup. Once the image is summed, it is displayed on the VGA monitor.

Microscope Optics

Microscope optics (Figure 3-9) include the:

- eyepieces
- turret
- objectives

Figure 3-9. Microscope Optics

① eyepieces

② turret

③ objectives

The KMS-310/400 uses two wide-field 10X eyepieces. Both eyepieces have rubber eyecups (for eyeglass wearers) and a 20.0 mm field-of-view capability (index). You can adjust the focus, angle and width of the eyepieces to suit your vision.

The prism adjustment lever extends from the right side of the trinocular head and controls a prism within the trinocular piece. When the lever is in, 100 percent of the light is directed to the eyepieces and none to the camera. When the lever is out, 80 percent of the light is directed to the CCD camera and 20 percent to the eyepieces.

A motorized, five-place turret (or nosepiece) holds and rotates the microscope objectives.

If you normally use only one thickness of substrate, a column limit switch (located on the column) can be used to prevent the objective from driving into the substrate.

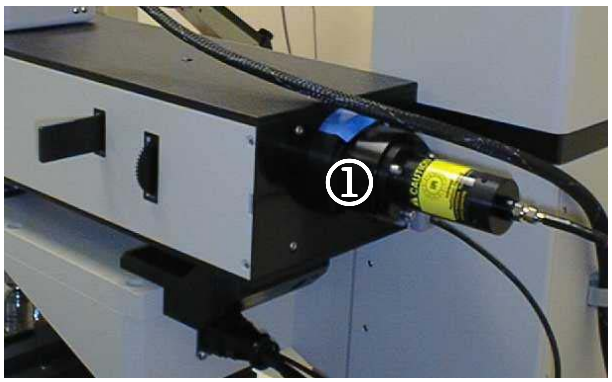
The KMS-310/400 can automatically adjust for differences in focus and centering between objectives. Once you focus and center a target under one objective, when you change objectives, the target will be in focus (parfocal from one objective to the other) and centered under the new objective (parcentric from one objective to the other). Offsets for the objectives can be saved to the system configuration file and then be recalled by the system to correct centering and focus as the turret is rotated to a new objective position.

Illumination Hardware

Illumination hardware consists of a lamp and associated power supply. The lamp, with associated collector lens, provides the lighting necessary to view the specimen through the confocal microscope.

The KMS-310/400 uses one of three different lamps: xenon, mercury or metal halide (Figure 3-10). All of these lamps come with an associated power supply. The xenon and mercury lamp houses are attached to the rear of the microscope. The metal halide lamp house is remotely connected to the K2-CDII module by means of a fiber optics light guide.

Figure 3-10. Illumination Options



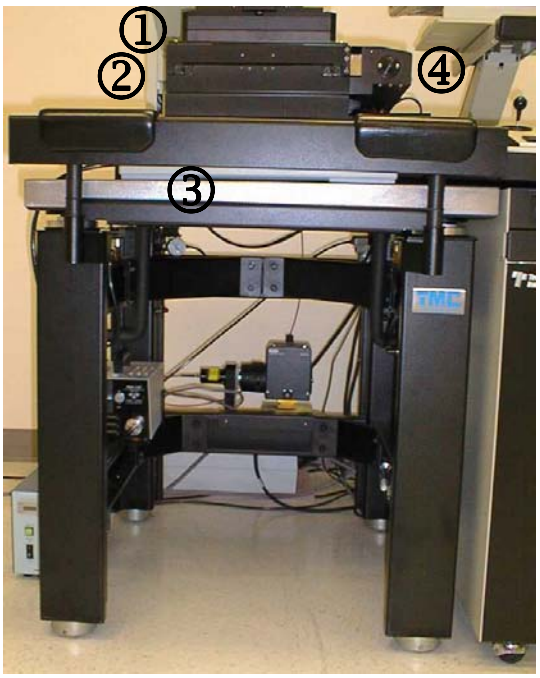
① lamp connection

Mechanical Subsystem

The mechanical subsystem (Figure 3-11) includes:

- a motorized stage
- Peizo assembly
- microscope mounting stand and column
- antivibration table
- articulated monitor stand

Figure 3-11. Mechanical Subsystem Components



① motorized stage

② Piezo assembly

③ antivibration table

④ articulated monitor stand

Motorized Stage

The KMS-310/400 system uses an advanced low profile, 8 in. x 8 in. stage. Individual servomotors drive precision zero backlash lead screws over the entire travel range. Travel range for reflected systems is 8 in. and 6.5 in. for reflected/transmitted systems.

Optical limit switches detect when the stage is at the end of the total travel range and establish a repeatable stage 'zero' position. Stage center is preset to 0,0 microns during installation.

The stage position is continuously monitored. When the Measure screen is displayed, the X-, Y-, and Z-axis (Piezo) stage positions are continuously displayed in the upper right corner of the monitor.

Peizo Assembly

The Piezo control assembly is mounted on top of the stages. The Piezo control assembly can support considerable weight in the Z-axis but is also very sensitive and can be damaged by jarring or displacement in the X or Y plane. The Piezo control assembly is held in place by steel guide pins that help prevent damage if a tight rotation is applied to the Piezo mechanism.

Microscope Mounting Stand and Column

Optics with associated Z-axis controls (coarse) are supported by a vertically mounted column. This entire assembly is placed on the antivibration, air-isolated table. The precision ground base has locating pins in which the X-Y table is centered.

The column supports the entire optics system and can be adjusted over approximately 3 in. of travel, depending on your capabilities. A DC motor drives the column and the absolute position is constantly monitored by a linear encoder attached directly to the column. The Z-axis motor position is also monitored by a rotary encoder attached directly to the motor.

Once the system is initialized, the Z-axis will return to a preset, rear focus position.

Antivibration Table

Due to the extremely fine focal plane and high magnification of the KMS-310/400 system, it is necessary to mount the stage, microscope and focusing column on an air-filled, antivibration table. The table uses four corner-mounted pistons that eliminate mechanical vibrations. This table requires a minimum compressed air (or nitrogen) supply of 50 psi (preferably 80 psi). A compressed air indicator gauge is visible from under the table. However, this gauge does not read actual line pressure psi.

When making measurements or observations, always be certain that all four corners of the antivibration table can be moved up or down independently without restriction.

Articulated Monitor Stand

The VGA monitor is mounted to the top of an articulated counterbalanced stand. This stand allows the screen position to be adjusted for comfort and individual preferences. The ergonomic features of this stand help minimize fatigue while working the system. To adjust the monitor position grip the front handle, then lift and push.

Functional Overview

This section provides an overview of the process used by the KMS-310/400 to capture, process, display and measure edge features.

System Control

All system operations are controlled through the software graphical user interface, including optical and mechanical operations, system and program setup, and execution of measurement.

Information entered with the keypad or keyboard is transmitted by bit-serial protocol to the KMS-310/400 control board (master interface board), which is plugged directly into the IBM-compatible 80486 computer system motherboard.

Image Input

Substrate images are captured by a CCD camera and transferred to the image grabber board.

The video image sensor of the CCD camera uses either a frame or image transfer method, depending on the model. With frame capture, each field is integrated on the sensor surface, transferred into storage (a frame buffer), and then read out (one line at a time) during the period on the next field.

The camera signal is coupled directly to the camera control unit. The signal is then sent to a digitizer and to the frame grabber. The resolution of the video capture and subsequent signal handling is 640 x 480 pixels. Each pixel location is analyzed for gray level by an 8 bit resolution decoder, with the location between pixels linearized based on gray levels from the preceding and succeeding pixels.

The frame grabber is a compound board with both a VGA display buffer and a video overlay buffer. The frame grabber receives the analog video source input signals from the CCD camera. Gain (contrast) and offset (brightness) for the signals can be programmed.

Image Processing

The video image is only usable for measurement once the system magnification for a given objective has been determined. The calibration standard used to determine system magnification contains a series of white and black lines of precisely known sizes. A submicron, chrome-on-glass standard traceable to NIST (U.S. Government) should be used to calibrate the instrument.

To calibrate magnification, the system performs each of these subroutines:

- pitch calibration
- line calibration
- image intensity profile generation

Pitch Calibration

Pitch calibration is used to determine the total magnification of the optical system. Optical systems have distortions in the image that cause blooming, a tendency for bright regions to push into dark regions. For this reason, dark lines may appear too small and white lines may appear too large. The pitch measurement avoids this problem by measuring the distance between two similar edges (e.g., from the left edge of one white line to the left edge of another white line). The most significant aspect of pitch calibration is that this establishes the one-to-one correspondence of actual versus measured geometry sizes. All programs that use the same magnification objective MUST contain the identical pitch factor in microns per pixel (as shown in the Calibration screen of each program).

Note: Pitch factors can also be viewed in the Calibration menu, which is found under the Master menu for any selected program.

Line Calibration

The errors in white or dark line measurements are compensated for by the line factor. After the total optical magnification is calibrated, a line is measured and compared with its known dimension. The difference is an error caused by the optics. This value is used to adjust the measurement to the correct result. The nominal calibration applies only to the type of substrate used during calibration (such as a binary chrome-on-glass standard used for binary chrome-on-glass photomasks).

Image Intensity Profile

The brightness of the video image is digitized to 256 levels of gray for the computer to analyze. This provides a representation of the surface for measurement. The optics blur the image slightly, so even a perfect black-to-white transition in the subject results in a slope from almost black to nearly white in the video. Since this slope is present, a white line is wider at the base than at the top. For this reason, a decision must be made as to where on this slope to make the measurement.

This decision point is the threshold, which is a percentage of the difference between the darkest and brightest points about the line. A 50 percent threshold is usually used, because this is halfway along the slope.

Image Measurement

The KMS-310/400 software analyzes the profile (waveform) for each line of pixels (video scan line), detecting the relative intensity of each pixel as a function of gray level. Each scan line is individually looked at for the threshold, based on the peak white and minimum black levels and the resulting measurement. The KMS-310/400 system contains both detection and measurement thresholds.

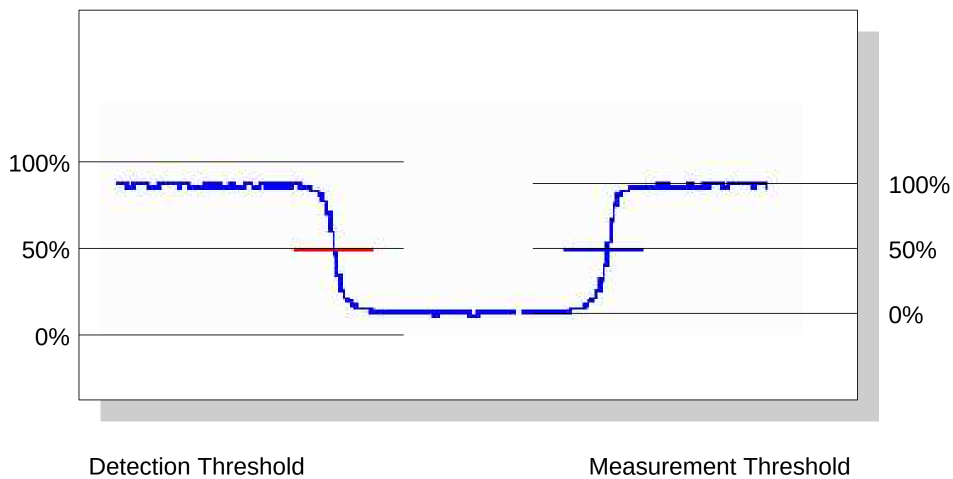
Detection Threshold

The detection threshold is calculated as the percent called out of the maximum minus the minimum light intensity, as detected for each measurement window. The selected edge from the previous calculation is used for the measurement calculations. If there is an edge below the requested percent for detection, the window ignores this portion and continues to scan in the direction requested for the first edge that satisfies all requirements specified (such as edge number, edge detection percentage, axis and direction of scan).

Measurement Threshold

The measured edge is determined from the edge found in the detection threshold calculation. The measurement point is determined by calculating the percent required of the maximum minus the minimum of the detected edge (as shown in Figure 3-12). This method of calculating the detection/measurement threshold allows the system to measure an edge with a poor signal such as a sub-half-micron space. The measurement threshold may not coincide with the detection threshold.

Figure 3-12. Detection Threshold versus Measurement Threshold



4 User Interface

Overview

Software Controls

Software Organization

Overview

This section provides an overview of the KMS-310/400 software environment, including modes of operation and terms used to describe software components.

Modes of Operation

The KMS-310/400 has two modes of operation: *production* and s*upervisor* mode. These two modes provide different levels of system control and are organized differently. Fab operators use the production mode menus to measure, record and store substrate test data. Process engineers use the supervisor mode menus to calibrate the system, set up measurement programs, and set up other important software parameters, as well as perform standard measurement tasks.

Note: This manual provides information about supervisor mode software screens only. For information about operator mode software screens, refer to the *KMS-310/400 Operator's Manual.*

Screen Components

A sample software screen, along with key software components, is shown in Figure 4-1. Software elements identified in Figure 4-1 include:

① icons

② the highlighted current selection

③ the message line

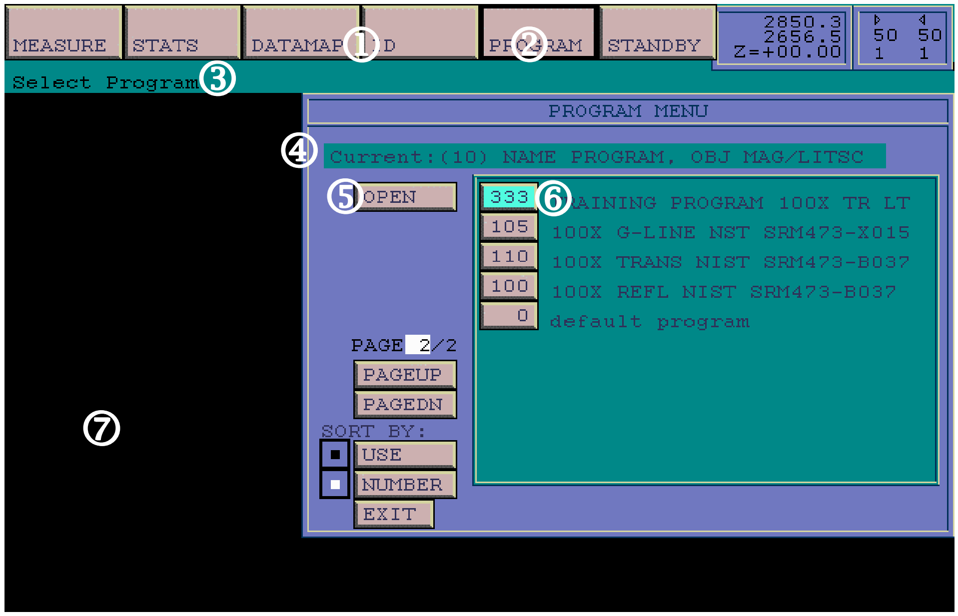
④ a dialog box

⑤ buttons

⑥ text fields

⑦ the video portion of the screen

Figure 4-1. Key Software Elements



Software Controls

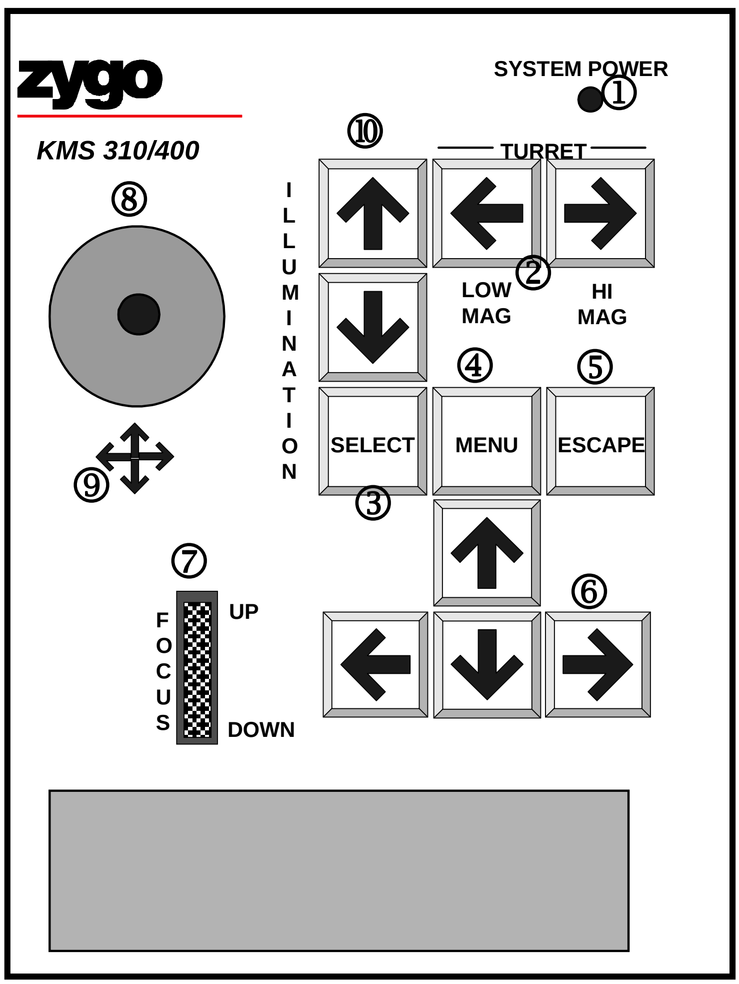
This section provides an overview of software controls, including keypad components and their uses, and keyboard/keypad parallel functionality.

Using the Keypad

The keypad (Figure 4-2) is the primary control device used to operate the KMS-310/400 system. It contains 11 keys, a joystick for control of the stage's X- and Y-axis, and a thumbwheel for fine focus.

You can control all system functions, except alphanumeric data entry, with the keypad.

Figure 4-2. KMS-310/400 Keypad



Functions for each of the individual keypad components shown in Figure 4-2 are listed in Table 4-1.

Table 4-1. Keypad Component Functions (Part 1 of 2)

Figure 4-2 Callout	Key/Control	Function
①	System power indicator	When lit, this LED indicates that the entire KMS-310/400 system is ready for operation.
②	Turret and arrow keys High mag and low mag	These keys change objectives by rotating the nosepiece (turret) clockwise and counterclockwise. Each time you press one of the arrow keys, the objective makes one change (representing a specific magnification). If the arrow key is immediately pressed a second time, the system will not accept a request for an additional change until the objective reaches position and the X, Y, and Z stages correct for the offsets programmed into the system. For this reason, once the objective reaches the detent spring position, there may be a slight delay before a second change of objectives will be accepted.
③	Select key	This key operates in conjunction with the highlighted buttons and icons displayed on the software screen. Once a button or icon is highlighted, press the *Select* key to activate the highlighted function. This key is the same as the [ENTER] key on the computer keyboard.
④	Menu key	This key activates a menu box associated with many of the icons. Pressing the *Menu* key displays additional menus associated with the highlighted icon.
⑤	Escape key	This key exits most of the currently selected screens or functions, such as an icon, menu or button. The [ESCAPE] key on the keyboard serves the same function as the *Menu* key.
⑥	Cursor arrow keys	These four keys are used to move from one icon or button to another on the various screens. They are used to change the measurement window's position and size, and to perform other functions once they have been selected.

Table 4-1. Keypad Component Functions (Part 2 of 2)

Figure 4-2 Callout	Key/Control	Function
⑦	Focus up/down thumbwheel	The thumbwheel is used to control the Piezo for fine focus movement of the substrate (viewed through the eyepieces or on the monitor). By carefully moving the THUMBWHEEL, you can control the Piezo to its full (manual) resolution capabilities of 0.01 microns to ±15 microns (20 microns on the KMS 310R/400R systems). Once the maximum of 15 microns is exceeded, the thumbwheel activates column focus.
⑧	Joystick	If the stage was initialized at the opening screen, the joystick can be used to directly control stage positioning. You can move in both the X and Y directions simultaneously. How fast you move the stage depends on how far you deflect the joystick.
⑨	Stage direction arrows	These arrows serve as directional guides when the joystick is used to control stage positioning.
⑩	Coarse focus (or) Illumination switches	These keys raise or lower the column without moving to and selecting the *Focus* icon.

Keypad/Keyboard Key Equivalents

The KMS 310/400 system includes a drawer-mounted, permanently attached keyboard in the electronics control unit. This keyboard is a full function keyboard and can be used for complete operation of the system, since each of the keys on the keypad have equivalent functions on the keyboard. Table 4-2 lists each keypad function and its equivalent keyboard command.

The keyboard is needed for alphanumeric and DOS entries, such as operator names and device IDs.

Table 4-2. Keypad/Keyboard Key Equivalents

Keypad Key	Keyboard Key
Select	[ENTER]
Escape	[ESCAPE]
Menu	[F4]
Arrow keys	Arrow keys
Turrent CCW (low mag)	'N' (either capital or small letter)
Turret CW (high mag)	'P' (either capital or small letter)

Hot Keys

Many commonly used KMS-310/400 system commands can be executed with a hot key shortcut.

Table 4-3 lists Measure screen hot keys and their functions. Table 4-4 lists script hot keys and their functions. Table 4-5 lists Title, Standby and Master Menu screen hot keys and their functions.

Table 4-3. Measure Screen Hot Keys (1 of 2)

Hot Keys	Action From Measure Screen
[ALT] + [a]	Automatically focus column.
[ALT] + [c]	Display slice range.
[ALT] + [g]	Toggle between mask (default) and stage coordinates (engineer advisement only).
[ALT] + [f]	Set focus parameters.
[ALT] + [q]	Display encoder position readout (not stage position (e.g., 1534814 893424).
[ALT] + [s]	[IMPORT] or [STORE] video image with filename request.

Table 4-3. Measure Screen Hot Keys (2 of 2)

Hot Keys	Action From Measure Screen
[ALT] + [t]	Spawn to DOS to edit scripts, copy from other files or directly edit a file and return to the Measure screen.
[ALT] + [u]	Select fast focus type as edge-specific or confocal surface.
[ALT] + [v]	Display software version.
[CTRL] + [A]	Turn image capture function on and off (should be turned off for normal operation).
[CTRL] + [E]	Display X-0, Y-0, and Z-0 errors (*.2um).
[CTRL] + [F]	Toggle logging position on and off.
[CTRL] + [T]	Toggle measure threshold between a fixed value of 50% and track detection threshold. **Caution**: the track detection threshold seeting will affect calibration.
[CTRL] + [W]	Report pixel location and position of windows on screen.
[F4]	Same use as [menu] key on the system keypad. This key stroke selects [MENU] when the menu is available under the current icon.
[CTRL] + [S]	Prints entire monitor screen to the hard drive as a *.BMP file.
[A]	Move directly from the Measure screen to the Script Start screen.
[SHIFT] + [N] or [F11]	Move the turret to the next position.
[P] or [F12]	Move the turret to the previous.
[O]	Report the current objective system for positions 1-5.
[SHIFT] + [A]	Activate Piezo autofocus.

Table 4-4. Script Hot Keys

Hot Keys	During Execution of Scripts
[ALT] + [S]	Toggle between silent and non-silent running. Silent running is the fastest speed, with command results not displayed on screen. Non-silent speed runs slightly slower, with the result of each command displayed as it is executed. **Caution**: executing this command during measurement will disrupt the measurement cycle.
[F4]	Toggle between *Silent:0* and *Debug:1* mode.

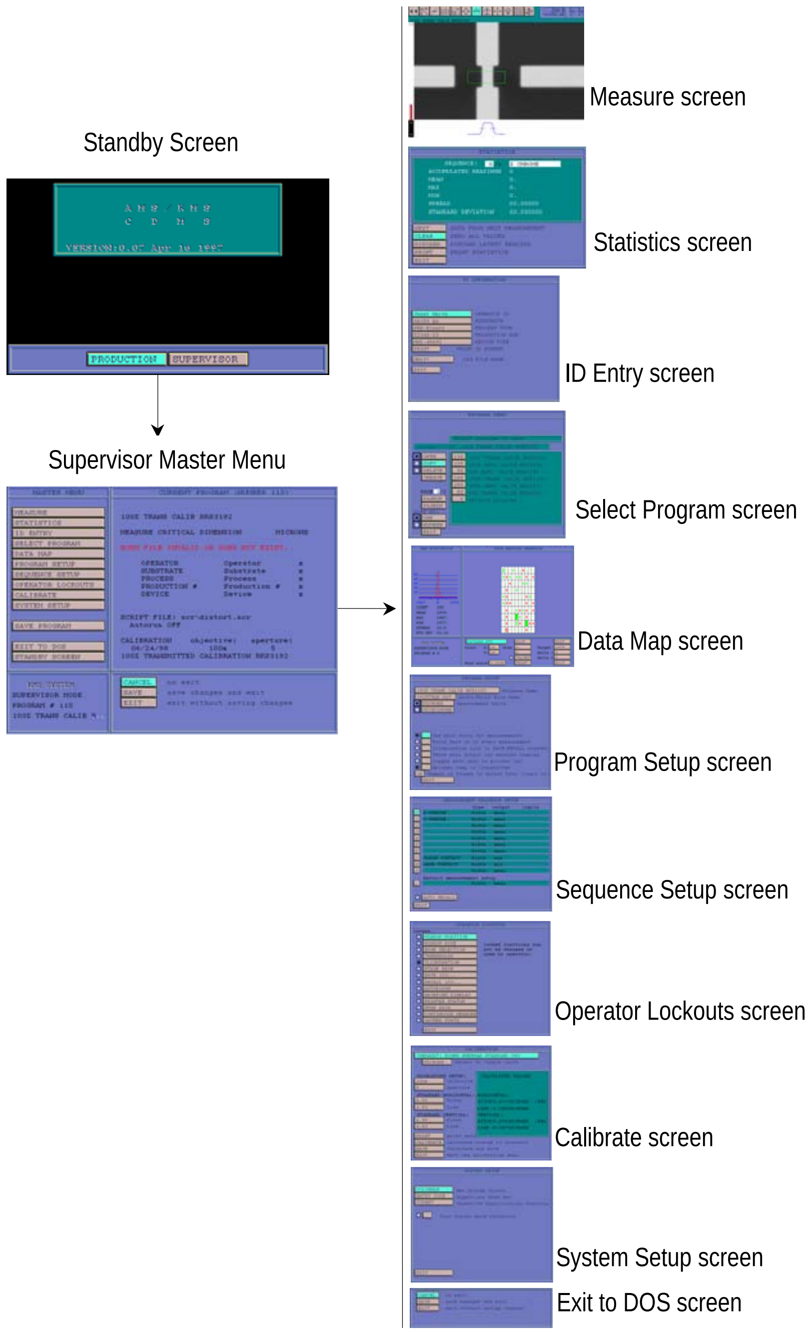
Table 4-5. Title, Standby, or Master Menu Screen Hot Keys

Hot Keys	Title, Standby, or Master Menu Screens
[SHIFT] + ~	Exit to DOS **Caution**: nothing will be saved once this command is executed.
↑ arrow on keyboard [F9]	Perform manual column focus. Using this command will move the substrate towards the objective (lower column).
↓ arrow on keyboard [F10]	Perform manual column focus. Using this command will move the substrate away from the objective (raise column).

Software Organization

This section provides an overview of the KMS-310/400 Supervisor Mode's software organization (Figure 4-3). Each of the elements in Figure 4-3 are discussed in greater detail in subsequent sections of this chapter.

Figure 4-3. KMS-310/400 Software Map

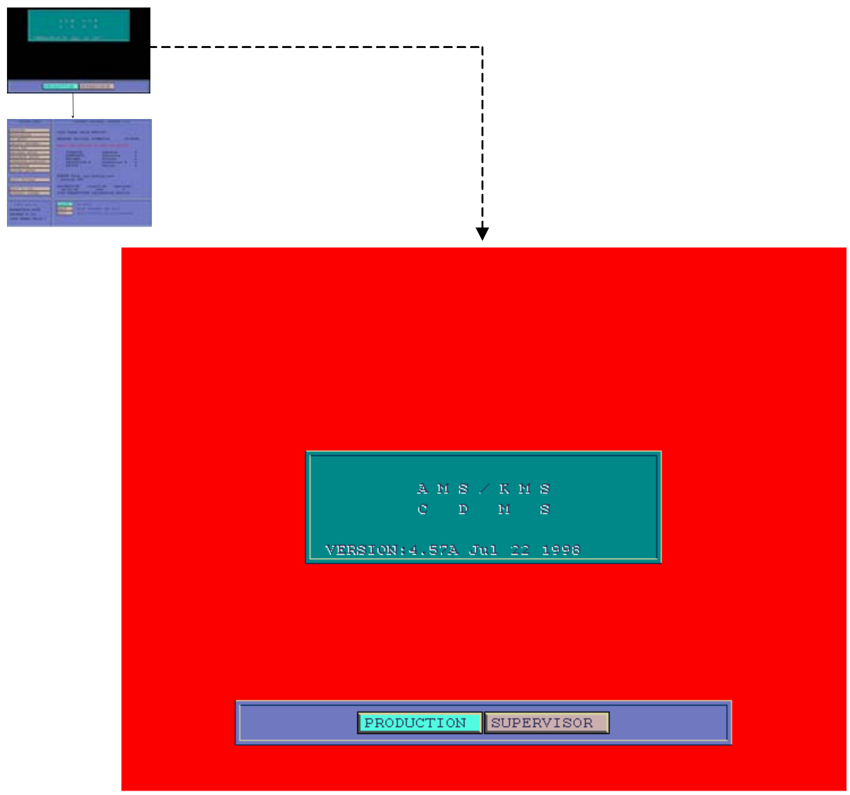


Standby Screen

The KMS-310/400 system displays the Standby screen (Figure 4-4) when the system is first turned on or when idle. This is the entry screen for both supervisor and production mode.

To display the Supervisor Master Menu screen from the Standby screen, select *Supervisor* and press [SELECT]**.**

Figure 4-4. Standby Screen



Supervisor Master Menu

The Supervisor Master Menu screen (Figure 4-5) is used to enter all submenus in production mode.

Supervisor Master Menu screen menu selections, along with their uses, are listed in Table 4-6.

Figure 4-5. Supervisor Master Menu Screen

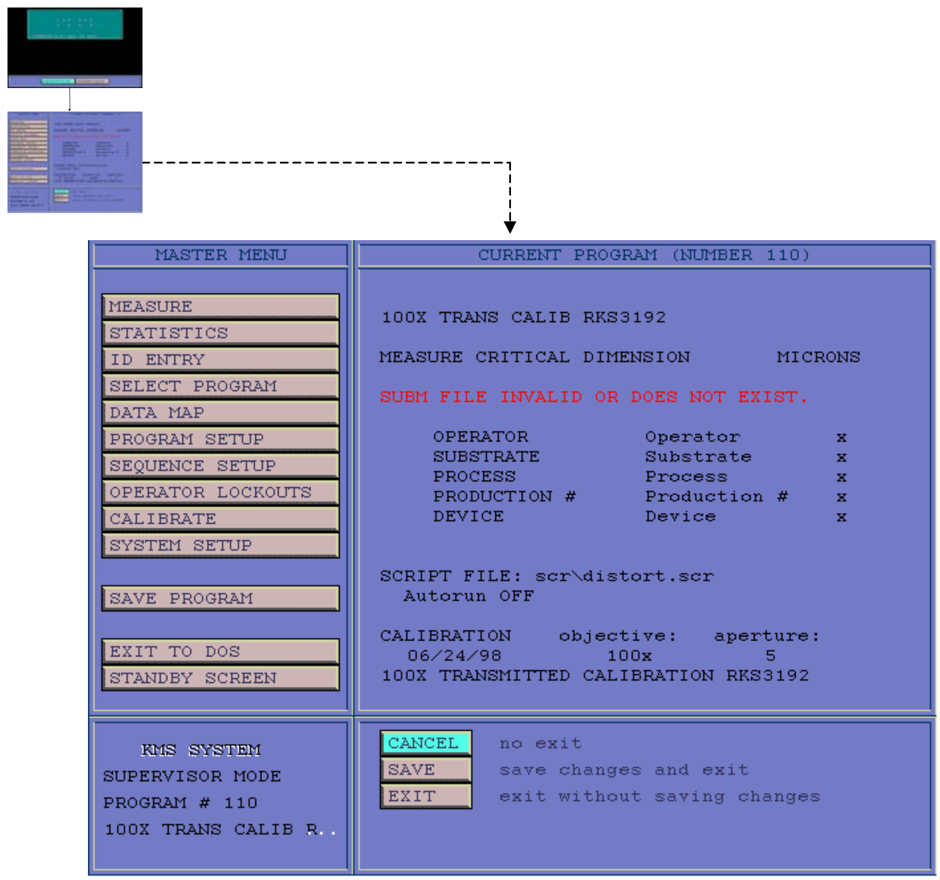


Table 4-6. Supervisor Master Menu Selections

Menu Selection	Use
Measure	Select this menu item to display the Measure screen with icons and submenus.
Statistics	Select this menu item to display the Statistics window.
ID Entry	Select this menu item to display the ID Information window.
Select Program	Select this menu item to display the Program window.
Data Map	Select this menu item to display the Data Map window.
Program Setup	Select this menu item to display the Program Setup window.
Sequence Setup	Select this menu item to display the Sequence Setup window.
Operator Lockouts	Select this menu item to display the Operator Lockouts window.
Calibrate	Select this menu item to display the Calibrate window.
System Setup	Select this menu item to display the System Setup window.
Save Program	Select this menu item to save the program.
Exit to DOS	Select this menu item to exit to DOS.
Standby Screen	Select this menu item to return to the Standby screen.

Measure Screen

The Measure screen (Figure 4-6) is used to perform measurement functions. Uses for each of the Measure screen icons are listed in Table 4-7.

To display the Measure screen:

1. From the Supervisor Master Menu Screen, highlight the *Measure* icon.
2. Press [SELECT].

   Press [ESCAPE] twice to exit the Measure menu at any time.

Figure 4-6. Measure Screen Icons

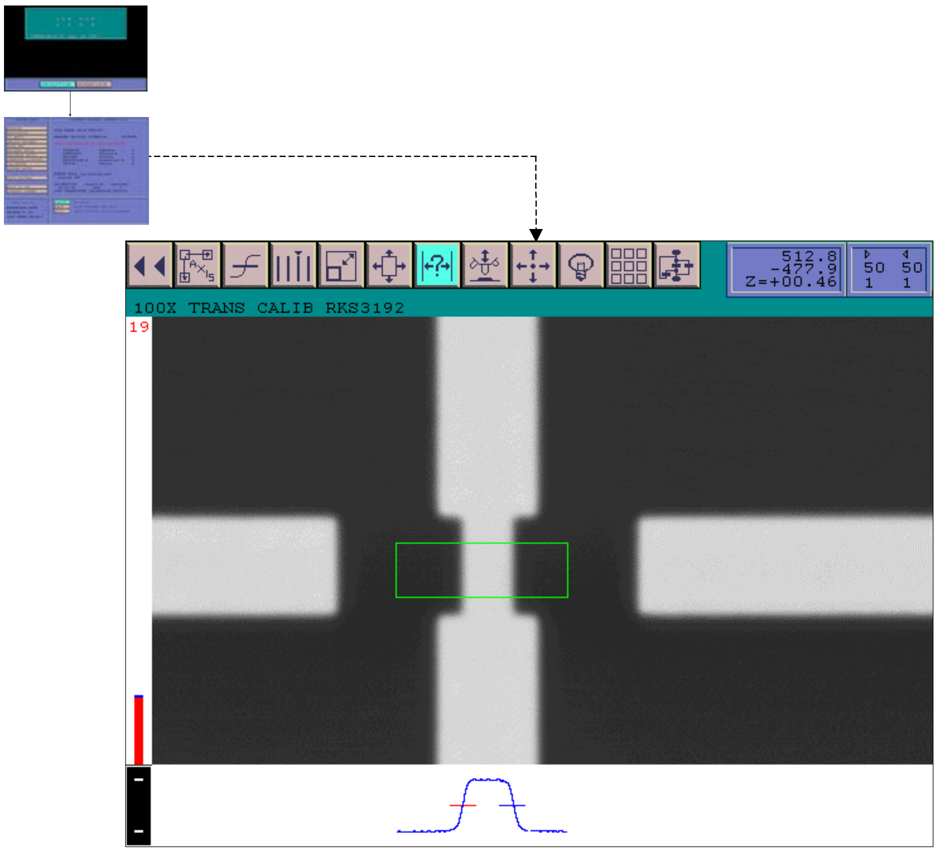
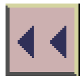
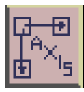
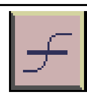
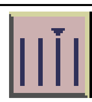
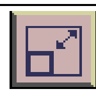
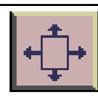
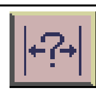
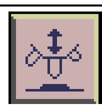
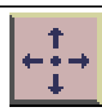
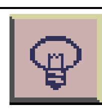
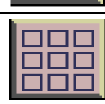
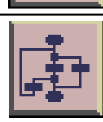


Table 4-7. Measure Screen Icons

Icon	Icon Name	Function
	Options	▪ Press [SELECT] to exit the Measure screen and return to the Supervisor Master Menu screen. ▪ Press [MENU] to capture a bitmap image, set up objectives, calibrate the Z-axis calibration and acquire image slices.
	Swap axis	▪ Press [SELECT] to toggle between horizontal and vertical axis measurements.
	Adjust thresholds	▪ Press [SELECT] to adjust the threshold. ▪ Use the up and down arrow keys to set the thresholds based on which edges you want to detect. ▪ Press [ESCAPE] once to return to the Measure Screen Icons. ▪ Press [MENU] to adjust the size of the intensity profile on the screen.
	Select edge	▪ Press [SELECT] to set edges for measurement detection within the left, right or both windows. ▪ Press [MENU] to change the seek direction for edge detection in either window.
	Size windows	▪ Press [SELECT] to set the size of the left, right or both windows.
	Position windows	▪ Press [SELECT] to set the position of both left and right windows, either together or separately.
	Measure	▪ Press [SELECT] to begin the measure sequence. ▪ Press [MENU] to display the Measure Controls menu.
	Focus	▪ Press [SELECT] to set the column coarse focus. ▪ Press [MENU] to set the relative focus speed for manual operation. ▪ Press [MENU] to change autofocus on either an edge or a surface in Confocal mode.
	Position stage	▪ Press [SELECT] to type in and move to known distances with raw or aligned (deskewed) coordinates. ▪ Press [MENU] to save or go to previously saved stage positions.
	Illumination	▪ Press [SELECT] to control the illumination gain and offset.
	Save/recall setup	▪ Press [SELECT] to save position, size, edge, threshold, and illumination settings, selected axes; or to recall previously saved settings.
	AMPS scripts	▪ Press [SELECT] to run, pause, go to, restart, or exit a script routine you typed in, or one that has been previously saved.

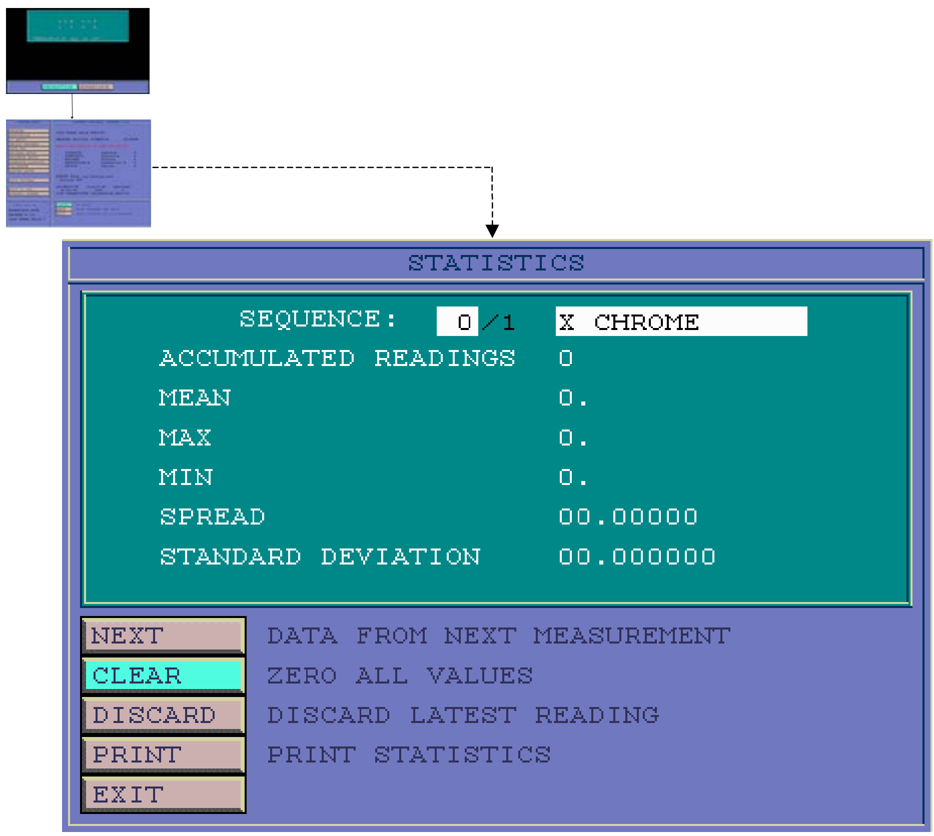
Statistics Menu

If this option is set up and saved in Supervisor Mode, measurement data automatically collected with each measurement is displayed in the Statistics window (Figure 4-7). Uses for each of the Statistics window buttons are listed in Table 4-8.

To display the Statistics window:

1. From the Supervisor Master Menu screen, highlight the *Statistics* icon.
2. Press [SELECT].

Figure 4-7. Statistics Window



Button selections in the Statistics window are shown in Table 4-8.

Table 4-8. Statistics Window Selections

Button	Function
Next	View data from previous measurement sequences if you make multiple measurements with a script.
Clear	Zero the values of all readings taken.
Discard	Remove only the last reading taken from the statistics calculations.
Print	Place all statistics data onto the hard disk or send it to a printer or host computer, depending on the setup created in Supervisor mode.
Exit	Return to the Supervisor Master Menu Screen.

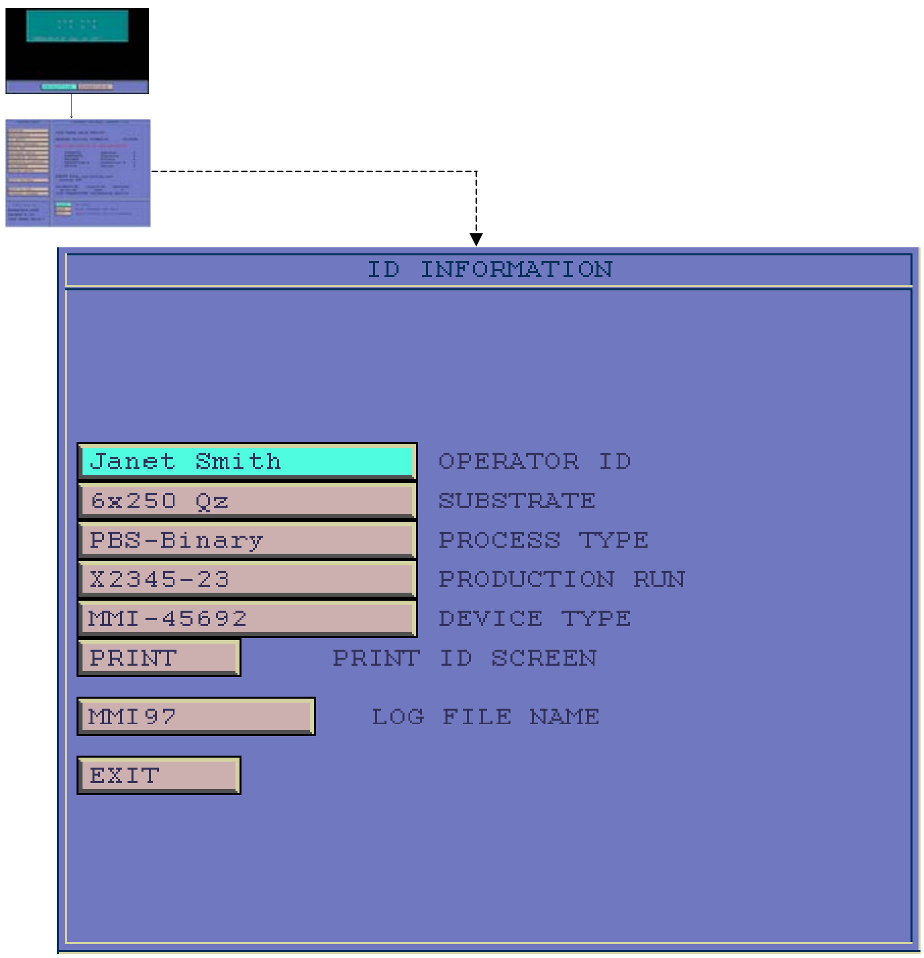
ID Information Menu

Use the ID Information window (Figure 4-8) to enter your name (or a number for production tracking purposes), information regarding the device you are measuring, or other device identification data. Uses for each of the ID Entry screen buttons are listed in Table 4-9.

To display the ID Information window:

1. From the Supervisor Master Menu screen, highlight the *ID Entry* icon.
2. Press [SELECT].

Figure 4-8. ID Information Window



Button selections in the ID Information window are shown in Table 4-9.

Table 4-9. ID Information Window Selections

Button	Function
Operator ID	Enter Operator Identification information such as the name.
Substrate	Enter the name of the substrate.
Process Type	Enter the name of the process type.
Production Run	Enter production run information.
Device Type	Enter information about the device type.
Print ID Screen	Print the ID Information the specified logfile.xxx on the hard drive.
Current Log File	Enter the filename using the following format: `Lfmmddyy.XXX` [LF = logfile name, mm = month, dd = day, yy = year, XXX = program number].
Exit	Return to the Supervisor Master Menu screen.

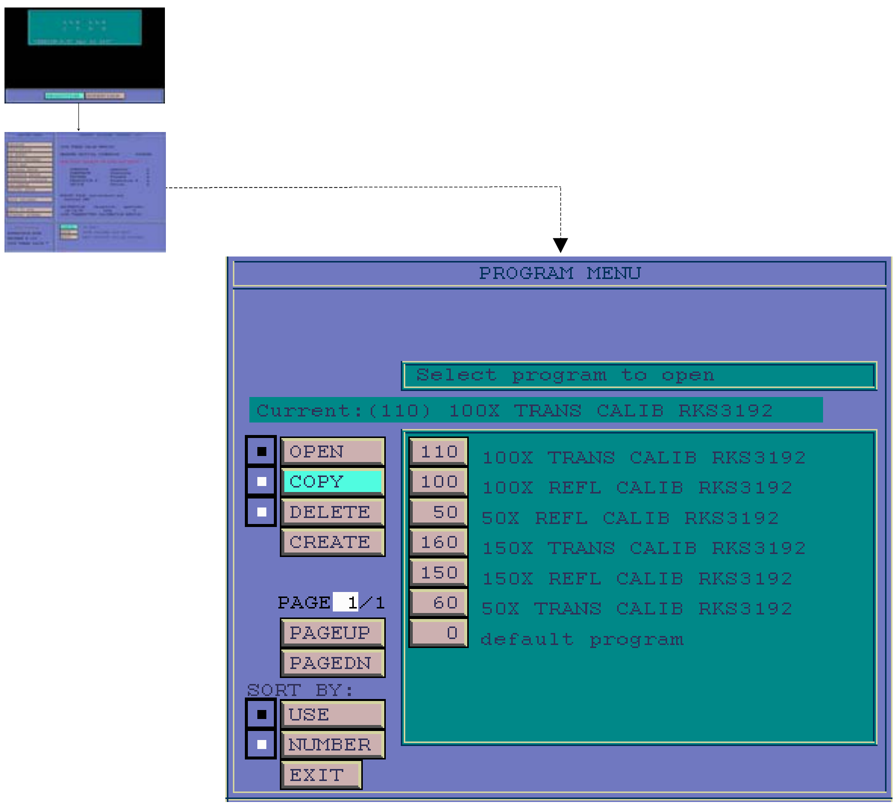
Select Program Menu

The Select Program window (Figure 4-9) is used to create a new program, open an existing program for modification, copy an existing program, or delete an existing program. Uses for each of the Select Program buttons are listed in Table 4-10.

To display the Select Program window:

1. From the Supervisor Master Menu screen, highlight the *Select Program* icon.
2. Press [SELECT].

Figure 4-9. Select Program Window



Button selections in the Select Program window are shown in Table 4-10.

Table 4-10. Select Program Window Selections

Button	Function
Open	Opens the Source File dialog box, allowing you to select a program to open You can select a source file to open from the source file list or enter a file number in the Source File dialog box.
Copy	Copy an existing program to a new program.
Delete	Opens the Destination Program dialog box, allowing you to select a program to delete
Create	Display the Destination Program dialog box to set the destination program.
Page up, page down	Move to the next or previous page.
Use	Toggle the Sort By Use selection on and off. When this item is selected, the checkbox adjacent to the item turns from white to black and programs will be sorted by order of use.
Number	Toggle the Sort By Number selection on and off. When this item is selected, the checkbox adjacent to the item turns from white to black and programs will be sorted by numeric order.
Exit	Return to the Supervisor Master Menu screen. When you exit the Select Program window, the program selected in the [OPEN] button is in use.

Data Map Menu

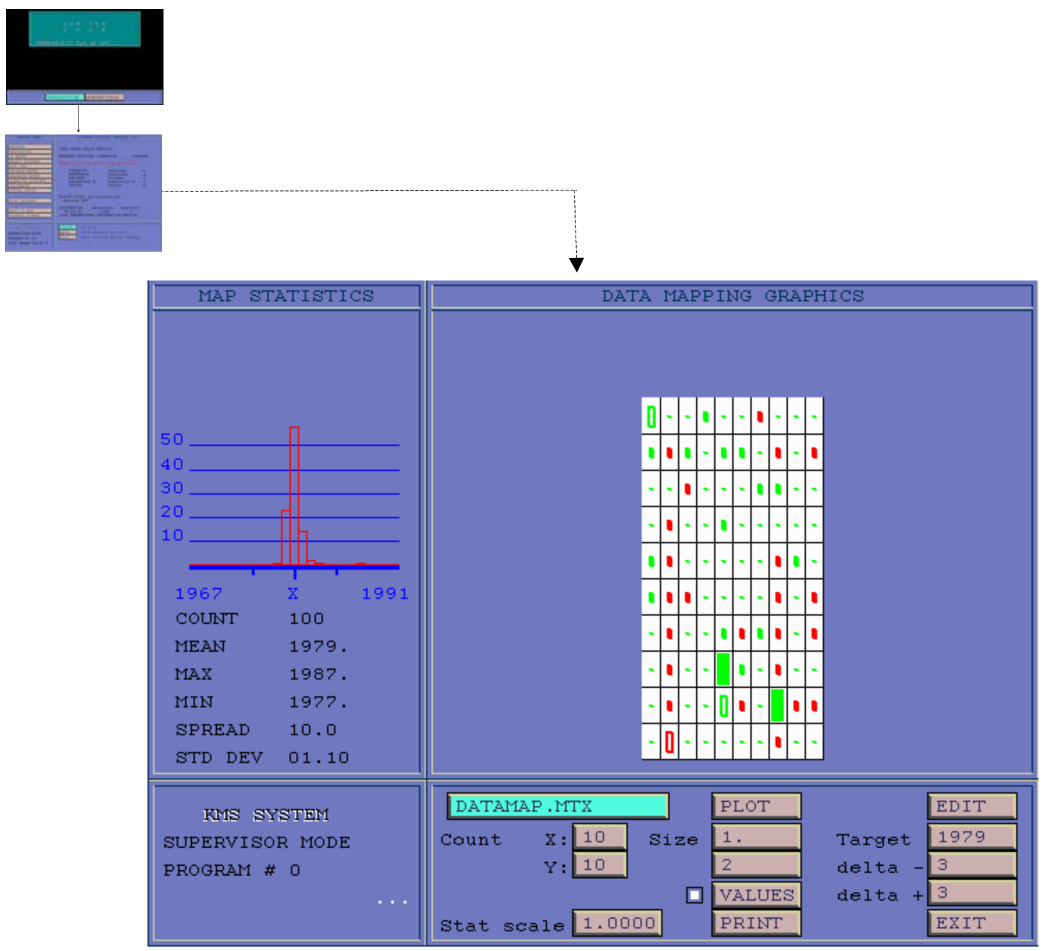
The Data Map window (Figure 4-10) is used to display measurement data in graphic form. Once the data is displayed, you may also edit individual values within the display. Uses for each of the Data Map screen selections are listed in Table 4-11.

The data map function is available with KMS systems only and can only be used once X/Y matrix-formatted measurements are complete.

To display the Data Map window:

1. From the Supervisor Master Menu screen, highlight the *Data Map* icon.
2. Press [SELECT].

Figure 4-10. Data Map Window



Button selections in the Data Map window are shown in Table 4-11.

Table 4-11. Data Map Window Button Selections

Button	Function
File name	Enter the file name.
Count	Set X and Y values.
Stat scale	Enter the statistics scale.
Plot	Plot the data map.
Size	Set the map size.
Values	Turn the values selection on and off. When this item is selected, the selection box adjacent to the item turns from white to black.
Print	Print map data to file. When you select [PRINT], the Log dialog box is displayed, prompting you to select the type of log data you want to print.
Edit	Make changes to the data mapping graph. When you select [EDIT], you can use the arrow keys to move around in the graph. Select [EDIT] to edit a data map value. Select [ESCAPE] to save editing changes.
Target	Set the target number.
Delta -	Set the Delta value.
Delta +	Set the Delta+ value.
Exit	Return to the Supervisor Master Menu screen.

Program Setup Menu

Use the Program window (Figure 4-11) to select the correct measurement program. The Program window lists the programs in the order they were used, from top to bottom. Uses for each of the Program Setup screen buttons are listed in Table 4-12. When a button is selected, the checkbox adjacent to the item turns from white to black.

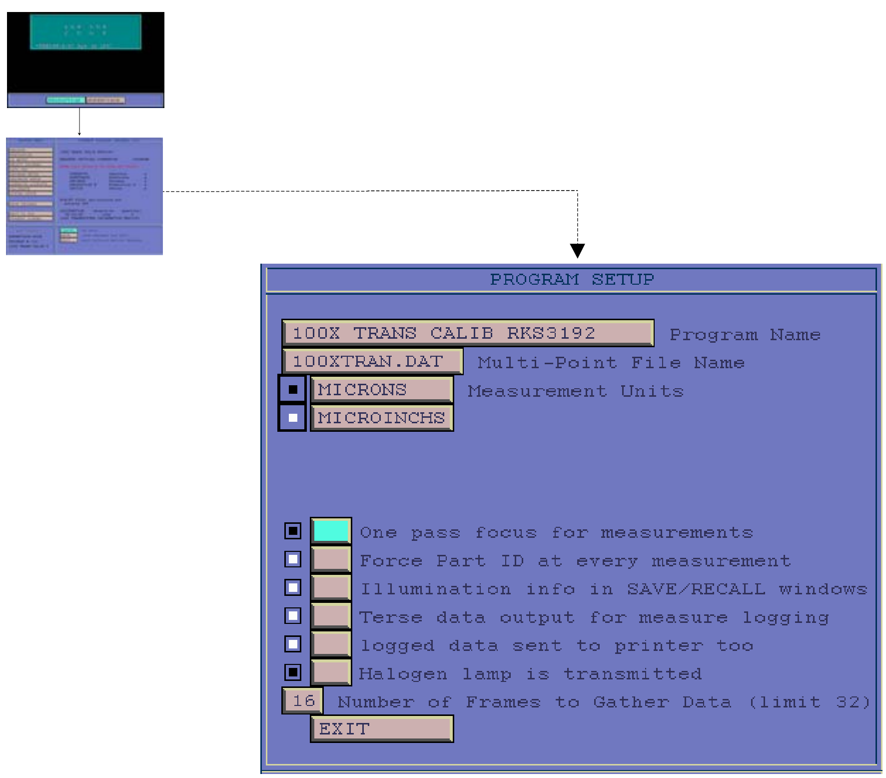
Selecting the correct program to operate is very important. The system will always return to the last program used, even after power has been turned off.

Tip: Remember that each program contains calibration values that are unique to only one total magnification. This requires that only one objective be used with that program if correct measurements are to be obtained.

To display the Program window:

1. From the Supervisor Master Menu screen, highlight the *Program Setup* icon.
2. Press [SELECT].

Figure 4-11. Program Menu Window



Button selections in the Program Setup window are shown in Table 4-12.

Table 4-12. Program Setup Window Selections

Button/Label	Function
Program name	Enter the name of the program.
Multi-point file name	Enter the multi-point file name.
Measurement units	Set the unit of measurement as microns or micro inches.
One pass focus	Use a single pass focus operation.
Force part ID at every measurement	Toggle on and off the *force part ID at every measurement* selection.
Illumination info in Save/Recall windows	Toggle on and off the *illumination information* selection in the Save/Recall window.
Terse data output for measure logging	Toggle on and off the *terse data for measure logging* selection.
Logged data is sent to printer too	Toggle on and off the *logged data sent to file* selection.
Halogen lamp is transmitted	Toggle the Halogen lamp on and off.
Number of frames to gather data	Set the number of frames to gather data (limit 32).
Exit	Return to the Supervisor Master Menu screen.

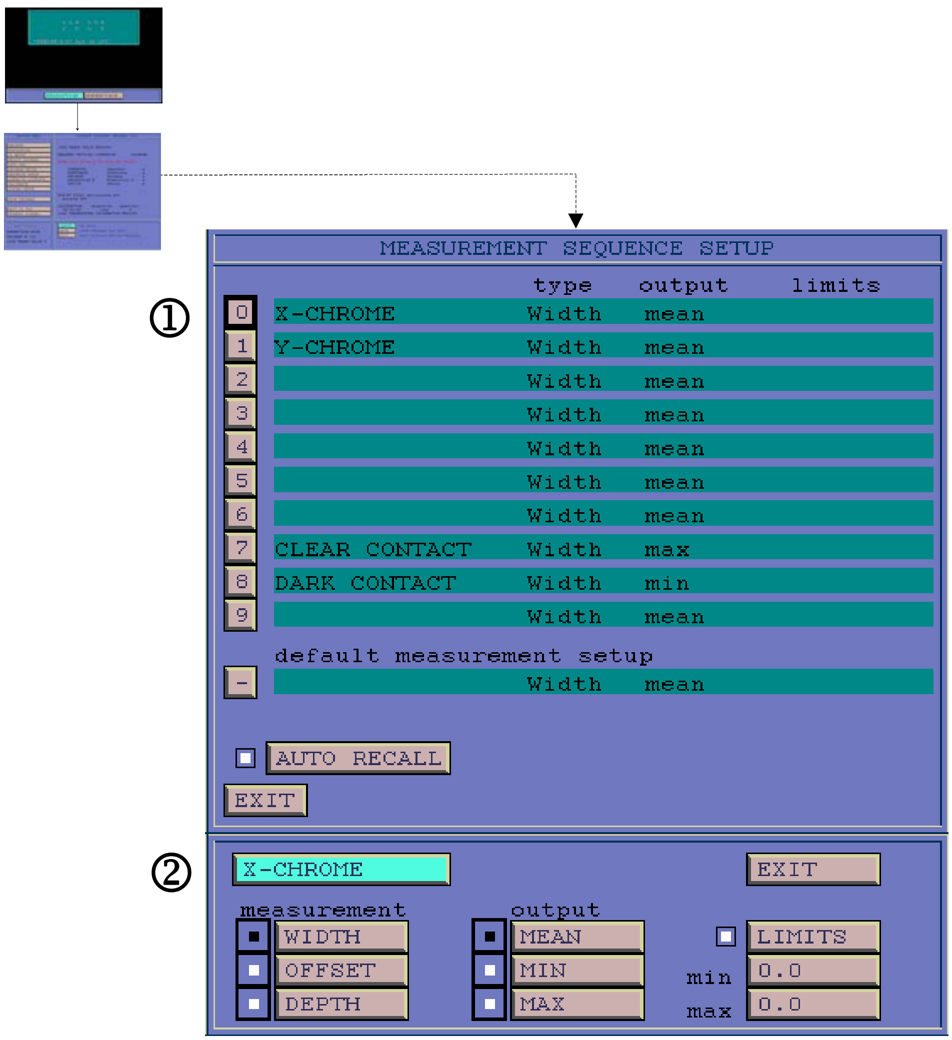
Sequence Setup Menu

The Sequence Setup window (Figure 4-12) is used to display measurement data in numerical form. Once the measurement data is displayed, you can edit individual values within the display or change the method of measurement. When an item is selected, the selection box adjacent to the item turns from white to black. Uses for each of the buttons in the Sequence Setup window are listed in Table 4-13.

To display the Sequence Setup window:

1. From the Master Menu screen, highlight the *Sequence Setup* icon.
2. Press [SELECT].

Figure 4-12. Sequence Setup Window



Button selections in the Sequence Setup window and subwindow are shown in Table 4-13.

Table 4-13. Sequence Setup Window and Subwindow Selections

Window	Button	Function
①	Measurement sequence setup	Set up the measurement sequence setup. Press [SELECT] to open the Sequence Setup subscreen.
①	Default measurement setup	Press [SELECT] to display the Measurement Sequence Setup dialog box and set up the default measurement.
①	Auto recall	Toggle on or off the *Auto Recall* selection.
①	Exit	Return to the Supervisor Master Menu window.
	Measurement Width Offset Depth	Toggle the *measurement* selection on or off. Normal horizontal/vertical measurement Not in use at this time Measure differences in height between adjacent surfaces.
②	Output	Select the method of calculation for data output as *mean*, *min* or *max*.
②	Limits	Toggle the *limits* selection on or off to set the minimum and maximum limits.
②	Exit	Return to the Sequence Setup window subscreen.

Operator Lockouts Menu

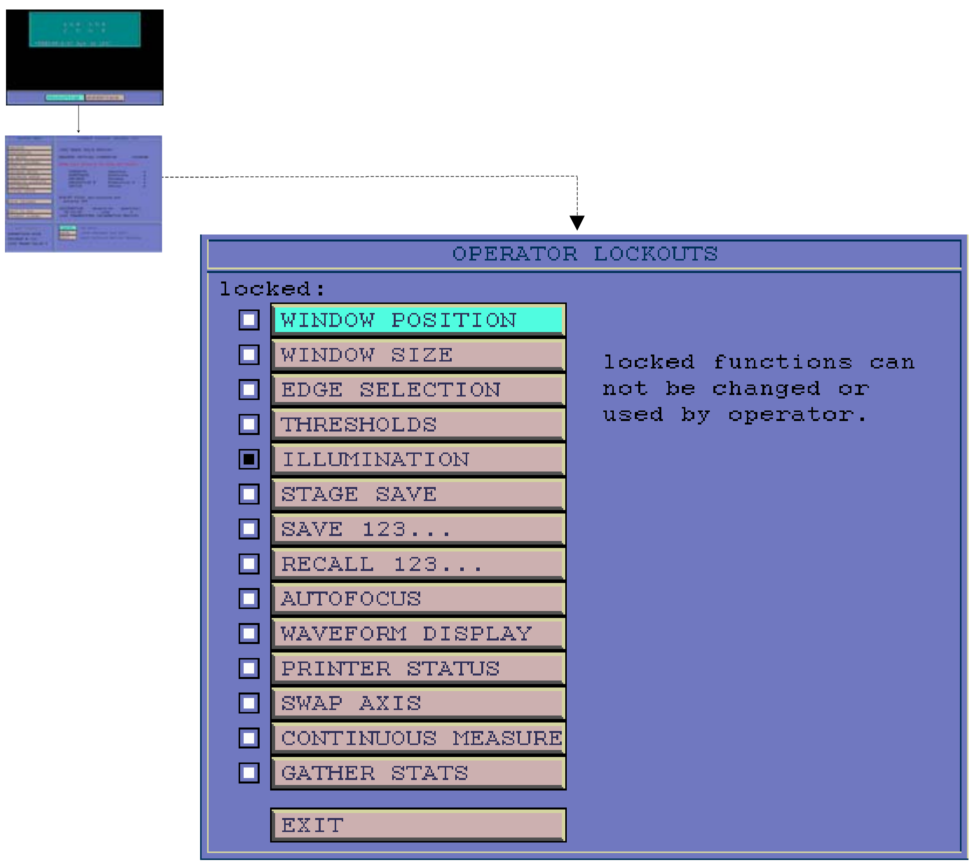
The Operator Lockouts window (Figure 4-13) is used to tag program setup functions for restricted use. Any function selected in the Operator Lockout menu will have a black diagonal line across it in the production mode Measure screen and be unavailable for use by operators.

When an item is selected in the Operator Lockouts window, the selection box adjacent to the item turns from white to black. Uses for each of the Operator Lockouts screen buttons are listed in Table 4-14.

To display the Operator Lockouts window:

1. From the Supervisor Master Menu screen, highlight the *Operator Lockouts* icon.
2. Press [SELECT].

Figure 4-13. Operator Lockouts Window



Operator Lockout window selections are shown in Table 4-14.

Table 4-14. Sequence Setup Window Selections

Button	Function
Window Position	Toggle the *Window Position* selection on and off to block or enable operator access to this function.
Window Size	Toggle the *Window Size* selection on and off to block or enable operator access to this function.
Edge Selection	Toggle the *Edge Selection* selection on and off to block or enable operator access to this function.
Thresholds	Toggle the *Thresholds* selection on and off to block or enable operator access to this function.
Illumination	Toggle the *Illumination* selection on and off to block or enable operator access to this function.
Stage Save	Toggle the *Stage Save* selection on and off to block or enable operator access to this function.
Save 123…	Toggle the *Save 123…*selection on and off to block or enable operator access to this function.
Recall 123…	Toggle the *Recall 123…* selection on and off to block or enable operator access to this function.
Autofocus	Toggle the *Autofocus* selection on and off to block or enable operator access to this function.
Waveform Display	Toggle the *Waveform Display* selection on and off to block or enable operator access to this function.
Printer Status	Toggle the *Printer Status* selection on and off to block or enable operator access to this function.
Swap Axis	Toggle the *Swap Axis* selection on and off to block or enable operator access to this function.
Continuous Measure	Toggle the *Continuous Measure* selection on and off to block or enable operator access to this function.
Gather Stats	Toggle the *Gather Stats* selection on and off to block or enable operator access to this function.
Exit	Return to the Supervisor Master Menu screen.

Calibrate Menu

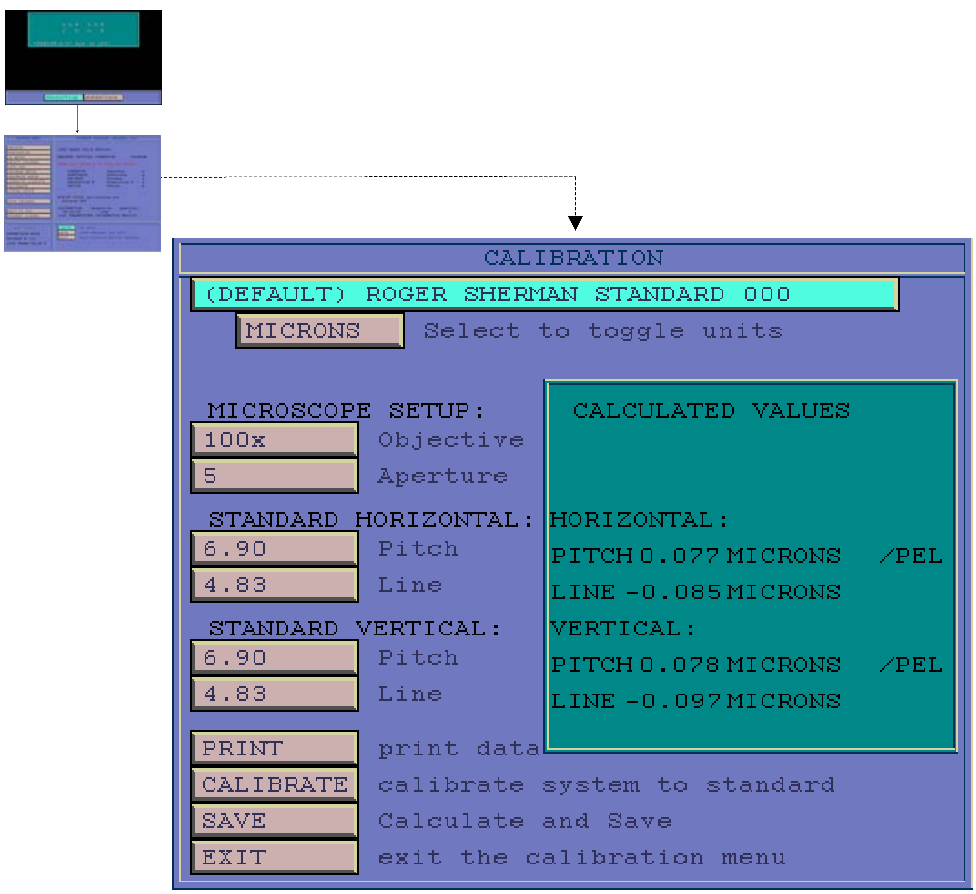
The Calibrate window (Figure 4-14) is used to calibrate the system when it is first set up. If the confocal and brightfield methods are both used for measurement, each objective must be calibrated for both of these microscopes. Uses for each button in the Calibrate window are listed in Table 4-15.

Note: You will need to create a seperate program and calibration file for each combination of illumination settings and mask type.

To display the Calibrate window:

1. From the Supervisor Master Menu screen, highlight the *Calibrate* icon.
2. Press [SELECT].

Figure 4-14. Calibrate Window



Button selections in the Calibration window are shown in Table 4-15.

Table 4-15. Calibration Window Selections

Button	Function
Calibration Method	Enter the name of the calibration standard to be used.
Units	Press [SELECT] to toggle between the *microns* and *micro inches* selections as the unit of measurement for calibration.
Objective	Select and set objective magnification.
Aperture	Select and set aperture to be used for measuring.
Standard Horizontal	Enter the horizontal pitch and line values.
Standard Vertical	Enter the vertical pitch and line values.
Calibrate	Calibrate system to standard. Press [Calibrate] to display the Calibration Controls dialog box in the Calibration subscreen.
Save	Calculate and save data to a hard disk log file.
Exit	Return to the Supervisor Master Menu screen.

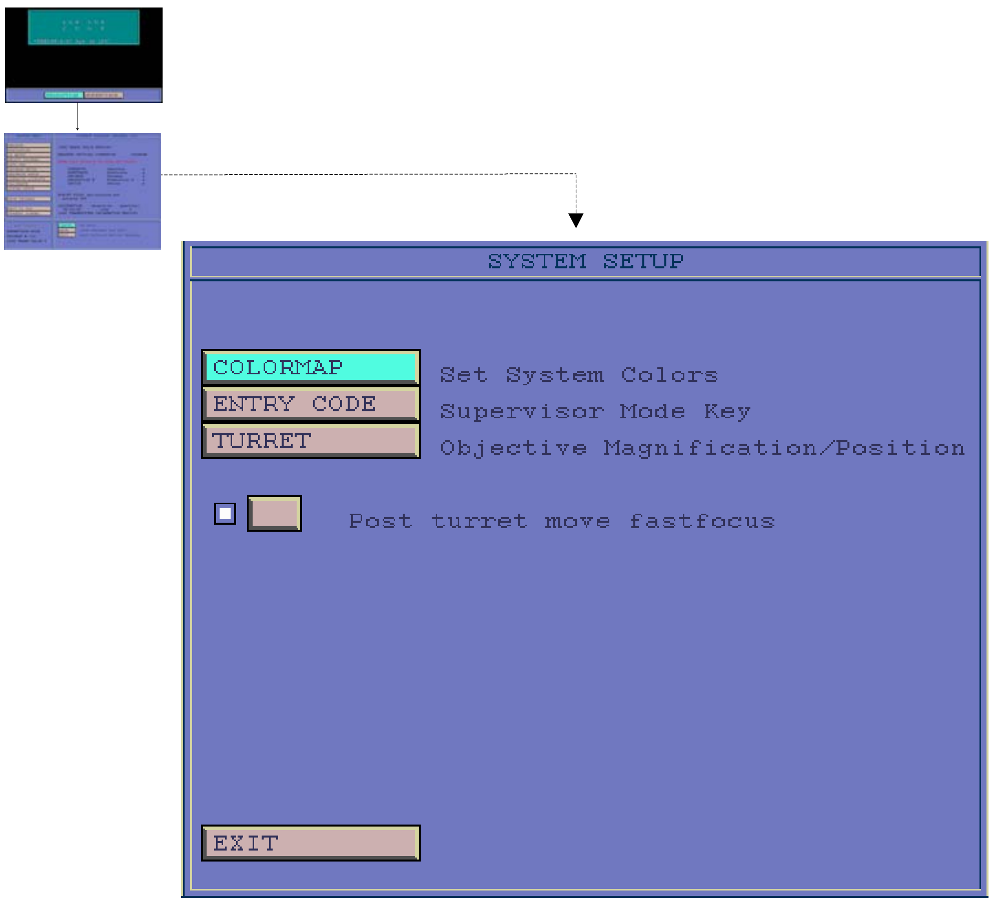
System Setup Menu

The System Setup window (Figure 4-15) is used to modify screen display colors, change your supervisor access code and assign objective positions on the turret. Uses for each button in the System Setup window are listed in Table 4-16. When an item is selected, the selection box adjacent to the item turns from white to black.

To display the System Setup window:

1. From the Supervisor Master Menu screen, highlight the *System Setup* icon.
2. Press [SELECT].

Figure 4-15. System Setup Window



Button selections in the System Setup window are shown in Table 4-16.

Table 4-16. System Setup Window Selections

Button	Function
Color Map	Select [COLOR MAP] to display the Color Map subwindow. Use the Color Map subwindow to change screen display colors. Select [DEFAULT] to display the system default colors. Select [RESET] to clear your selections. Select [EXIT] to return to the System Setup window.
Entry Code	Select [ENTRY CODE] to display the Change Access Code subwindow. You can enter a new code, save it and select [EXIT] to return to the System Setup window. **Note**: check with the installation engineer for initial setup of this function.
Turret	Select [TURRET] to display the Turret subwindow. Set the objective magnification position, save the configuration and select [EXIT] to return to the System Setup window.
Post Turret Move Fastfocus	Toggle the *Post Turret Move Fast Focus* on and off to select or deselect this option.
Exit	Return to the Supervisor Master Menu window.

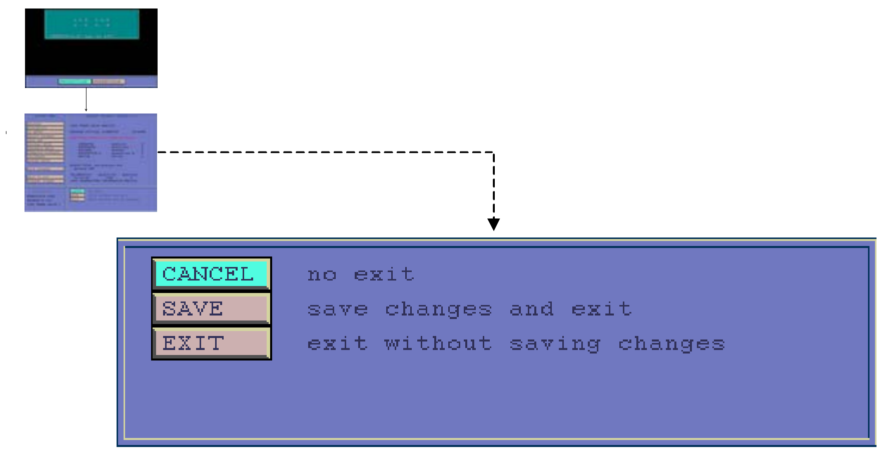
Save Program Menu

The Save Program window is used to save a program (Figure 4-16). Uses for each Save Program window selection are listed in Table 4-17.

To display the Save Program window:

1. From the Supervisor Master Menu screen, highlight the *Save Program* icon.
2. Press [SELECT].

Figure 4-16. Save Program Menu Window



Button selections in the Save Program window are shown in Table 4-17.

Table 4-17. Save Program Window Selections

Button	Function
Cancel	Cancel the command and return to the Supervisor Master Menu screen.
Save	Save changes and exit to the Standby Screen.
Exit	Exit to the Standby screen without saving changes.

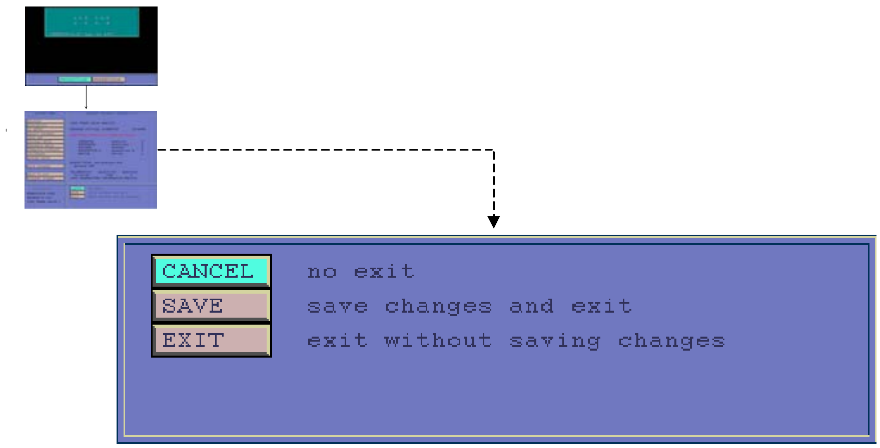
Exit to DOS

The Exit to DOS window (Figure 4-17) is used to save your work and exit or the Supervisor Master Menu screen. Uses for each Exit to DOS window selection are listed in Table 4-18.

To display the Exit to DOS window:

1. From the Supervisor Master Menu screen, highlight the *Exit to DOS* icon.
2. Press [SELECT].

Figure 4-17. Exit to DOS Window



Button selections in the Exit to DOS window are shown in Table 4-18.

Table 4-18. Exit to DOS Window Selections

Button	Function
Cancel	Cancel the command and return to the Supervisor Master Menu screen.
Save	Save program and system settings and exit to DOS.
Exit	Exit to a DOS window without saving your work.

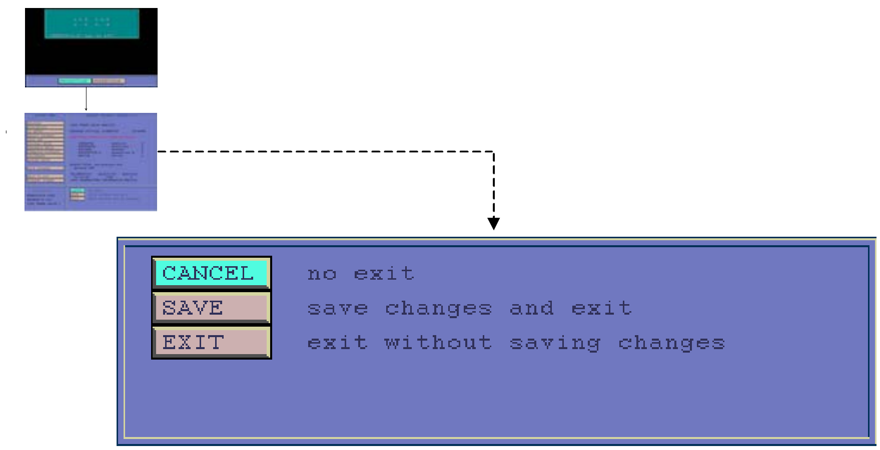
Return to Standby Selection

Use this selection to return to the Standby Screen (Figure 4-18). Uses for the Standby Screen selections are listed in Table 4-19.

To return to the Standby screen:

1. From the Supervisor Master Menu screen, select the *Standby Screen* icon.
2. Press [SELECT].
3. Select [EXIT] to exit the Supervisor Master Menu screen and return to the Standby screen.

Figure 4-18. Return to Standby Selection



Button selections in the Standby Screen window are shown in Table 4-19.

Table 4-19. Standby Screen Window Selections

Button	Function
Cancel	Cancel the command and return to the Supervisor Master Menu screen.
Save	Save changes and exit to the Standby Screen.
Exit	Exit to the Standby screen without saving changes.

5 System Setup

Overview

This chapter provides detailed instructions for setting up the KMS-310/400 software in supervisor mode.

Note: For an overview of the Supervisor software screens, screen components and software controls, refer to *Chapter 4: User Interface*.

This chapter is organized into the following sections (Figure 5-1):

- *Overview*, which provides an overview of the chapter's organization and procedures contained in each of the chapter's sections.
- *Configure Illumination Settings*, which provides procedures for setting up the transmitted condenser and illumination, adjusting illumination controls, as well as adjusting coarse and Piezo fine focus settings.
- *Define Calibration Parameters*, which provides procedures for calibrating the microscope, as well as horizontal and vertical settings.
- *Define System Options*, which provides procedures for changing the color map, changing your supervisor access code, and configuring objective assignments on the turret.
- *Set Objective Parfocality and Parcentricity*, which provides procedures for defining objective parfocality and parcentricity.
- *Adjust Autofocus Parameters*, which provides procedures for defining and adjusting system autofocus parameters.

Figure 5-1. Chapter 5 Overview

Configure illumination settings

- Set up the transmitted condensor
- Set up transmitted illumination
- Adjust illumination control
- Adjust focus control

Define calibration parameters

- Select calibration parameters
- Calibrate the microscope
- Calibrate horizontal settings
- Calibrate vertical settings
- Configure single-point calibration
- Save calibration settings

Define system options

- Display the System Setup window
- Set map colors
- Change your supervisor code
- Change turret objective assignments

Set parfocality and parcentricity

- Set objective parfocality and parcentricity

Adjust autofocus parameters

- Set column autofocus
- Set Piezo autofocus algorithm

Configure Illumination Settings

This section provides the following procedures for configuring and adjusting illumination settings:

- set up the transmitted condensor
- set up transmitted illumination
- adjust illumination controls

Set Up the Transmitted Condenser

You can set up the transmitted condensor in one of two ways:

- *Method 1:* Visually set up the transmitted condensor using the ocular eyepieces, or
- *Method 2:* Set up the transmitted condensor using the CONDENSR.SCR script.

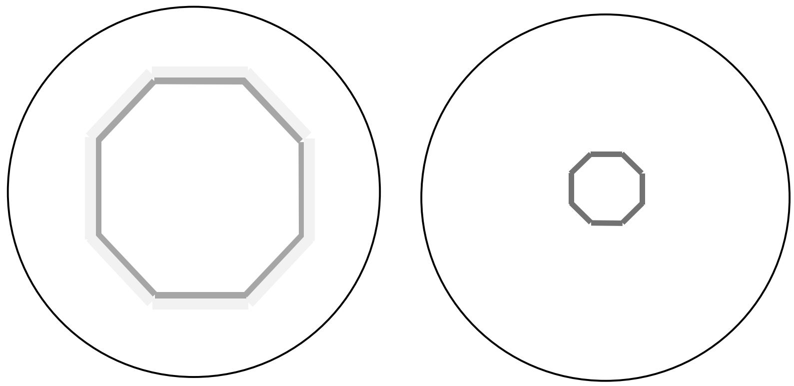
Method 1: Visually Set Up the Transmitted Condensor with the Ocular Eyepieces

To set up the transmitted condensor using the ocular eyepieces:

1. Place the photomask on the stage with the chrome side up.
2. Focus the system on an edge of a chrome feature.
3. Move the chrome edge to the edge of the oculars.
4. Set illumination to minimize eye stress while viewing the image of the aperture through the ocular eyepieces.
5. Turn the front knob on the transmitted light assembly clockwise until it comes to the mechanical stop (approximately 3/4 to 1 turn).

6. Close down the aperture so it is completely visible in the ocular eyepieces at 10X (Figure 5-2).

Figure 5-2. Aperture in Ocular View and Focus



Aperature partially closed while viewing in the oculars. Image of aperture is out of focus.

Aperture completely closed while viewing in the oculars. Image of aperture is in focus.

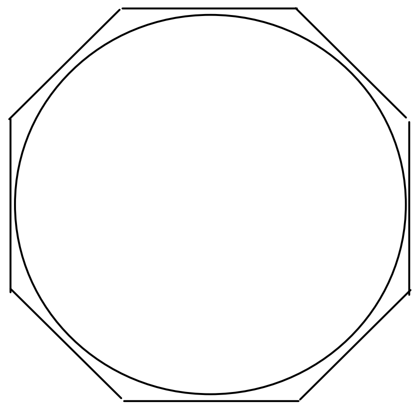
7. While viewing the aperture in the oculars, turn the rear knob on the transmitted light assembly until the image is in focus (Figure 5-2).

   The best focus is found when neither a blue or red flare is seen around the aperture when seen through the oculars.

8. Open the aperture to slightly overfill the 10X objective (Figure 5-3) once the focus is found.

   This is accomplished by rotating the aperture knob (the front knob on the transmitted assembly) counterclockwise.

Figure 5-3. Aperture Open to Overfill.



9. Set the illumination for each objective.

Method 2: Set Up the Transmitted Condensor Using the CONDENSR.SCR Script

To set up the transmitted condenser using the CONDENSR.SCR script:

1. Place the photomask on the stage with the chrome side up.
2. Focus the system on an edge of a chrome feature.

   The chrome image should be out of the measurement screen completely when looking at the monitor.
3. Set illumination so that the camera is not overdriven while working in the 10X objective.
4. Rotate the front knob on the transmitted light assembly clockwise until it comes to the mechanical stop (approximately 3/4 to 1 turn).
5. Close down the aperture so it is completely visible in the oculars at 10X (Figure 5-2).

6. Load the CONDENSR.SCR script using the *Script* icon (Figure 5-4).

Figure 5-4. CONDENSR.SCR Script

```
//:CONDENSR.SCR
//:THIS SCRIPT IS DESIGNED TO ASSIST WITH THE FOCUS OF THE CONDENSER
//:THE SCRIPT WILL ASK THE USER TO SET A MEASURE WINDOW ON A SECTION
OF
//:A FEATURE.  AT THIS POINT THE SCRIPT WILL BEGIN TO OUTPUT THE
RELATIVE
//:INTENSITY OF THE BRIGHT AREA.  THE USER SHOULD THEN ADJUST THE
CONDENSER
//:TO YIELD THE MAXIMUM VALUE OF THE METER, AS OUTPUT ON THE SCREEN

MENU: V99 "MOVE TO A CLEAR AREA ON THE MASK"
MESSAGE: SET MEASURE WINDOW OVER CLEAR AREA
OPERATOR:

GETWIN: V10 V11 V12 V13

MATH: V30=0
MARK: REPEAT
ERASE:
MATH: V30=V30+1

BOX: V10 V11 V12 V13 2
RP_WIN: V10 V11 V12 V13
METER: V20

TEXT: 100 100 2 "INTENSITY = %", V20
PAUSE: 1
MATH: V31=V30=0
LOOP: V31 REPEAT
EXIT:
```

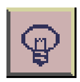
7. Move to a clear area on the mask, focus on an object and move the chrome edge to the edge of the oculars.
8. Set the measure window over a clear area.
9. With the aperture closed down completely, move the measurement boxes to the center of the aperture on the screen.
10. Press [SELECT] twice to start the script.
11. The message “INTENSITY = xxx” (xxx is an intensity value output) will be displayed in the upper left portion of the screen.
12. Rotate the rear knob on the transmitted condenser assembly to change the focus of the condenser.
13. As the number “xxx” in the “INTENSITY =” message increases, the condenser will be in better focus. The optimal condenser focus is achieved when the value is at its maximum.
14. Press [ESCAPE] to stop the script.
15. Set the illumination for each objective.

Set Up Transmitted Illumination

This section provides instruction for setting up the transmitted illumination controls in order to maximize the illumination signal while minimizing noise. The basic steps required to set up transmitted illumination include:

- setting illumination power (percent illumination)
- adjusting camera gain (KMS-400RT system only)
- configuring the electronics (frame grabber) controller for gain, offset and analog gain

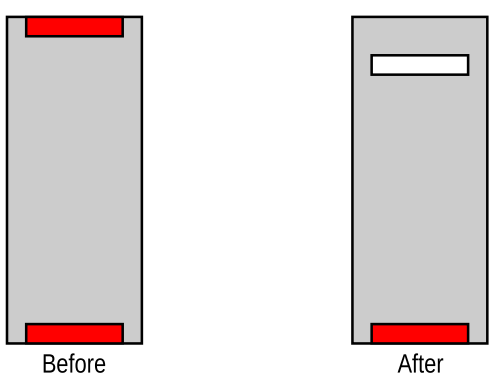
To set up transmitted illumination:

1. Place an artifact on the stage and focus at 10X.
2. Position a feature into the center of the measurement screen.
3. From the Measure Screen, select the *Window* icon and adjust the measurement window so that it falls across the feature on the screen.
4. Highlight the  icon and press [MENU].
5. Set the following values:
   - Gain = 31
   - Offset = 31
   - Analog = 1
6. Use the arrows on either side of the number read-out bar to adjust the percent illumination up or down so that the upper slide bar floats just below the point it turns red.

   When the percent illumination is correctly adjusted, the bar is white and will move up and down slightly (Figure 5-5).

Note: You may need to slightly adjust the gain in order to correctly position the bar for percent illumination.

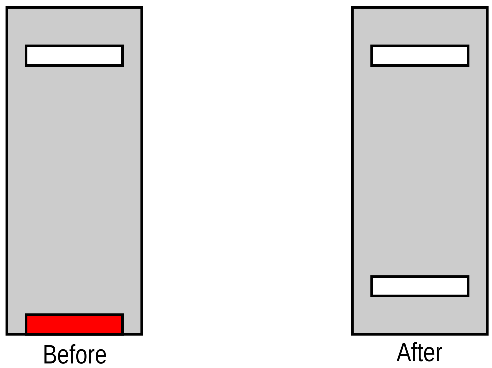
Figure 5-5. Percent Illumination Read-out Bar



7. Use the arrows on either side of the number read-out bar to adjust the offset up or down so that the lower slide bar on the measurement screen is floating just above the point at which it is no longer red (Figure 5-6).

   Once adjusted correctly, the bar should be white and moving up and down slightly.

Figure 5-6. Offset Adjust Value



Note: Perform Step 8 only if you are configuring transmitted light.

8. Ensure that the system has illumination values as shown in Table 5-1.

Table 5-1. Illumination Ranges

Objective	Illumination	Gain	Offset	Analog Gain	Camera Gain*	Camera Shutter*
10X	30-35	31-35	47-56	1	5-7	5-6
50X	45-55	31-35	47-56	1	10-15	6-7
100X	50-75	31-35	47-56	1	15-20	8
150X	60-90	31-35	47-56	1	15-20	8

** KMS-400 systems only*

9. Adjust the other objectives while the Illumination pop-up menu is still on the screen, then rotate the turret to the next objective.
10. Repeat steps 5-7 for each objective.
11. To save illumination settings for the KMS-310:
    a. Press [ESCAPE] to exit the Illumination submenu.
    b. Press [ESCAPE] to exit the Measurement screen and return to the Master Menu.
    c. Select *Save Program* and press [ENTER].
12. To save illumination settings for the KMS-400 system:

a. Select *Set Objective* in the Illumination menu and press [ENTER].

b. Press [ESCAPE] to exit the Illumination menu.

c. Press [ESCAPE] to exit the Measurement screen and return to the Supervisor Master Menu screen.

d. Select *Save Program* and press [ENTER].

13. To copy illumination settings to new or other programs:

a. Return to the Supervisor Master Menu screen and select the *Select Program* button.

b. Select *Copy* and press [ENTER].

c. Select the program to be copied, type in the number of the new program and press [ENTER].

Adjust Illumination Controls

If the system illumination gain and offset are set correctly, the height of the image intensity profile at the bottom of the screen will be at least 3/4 in. high. If the gain and offset are not correctly set, you may need to make adjustments to the illumination control.

This section provides two alternative methods of adjusting illumination settings. Which one you use depends on your personal preference.

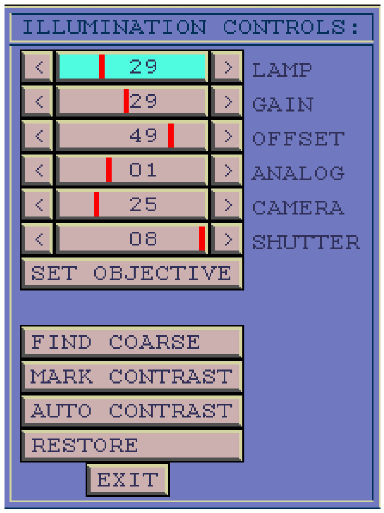
Adjustment Method 1

To adjust illumination control using method 1:

1. From the Measure screen, highlight the  icon and press [SELECT].

   The Illumination subscreen is displayed (Figure 5-7).

Figure 5-7. Illumination Subscreen



2. Press [SELECT] until *XX GAIN* is displayed.
3. Use the ↑and ↓ arrow keys to set the top portion of the vertical rectangle so that it is black, does not bounce into red, and so that the top curve of the image intensity profile is not flattened (saturated).
4. Press [SELECT] until *XX OFFSET* is displayed.
5. Use the ↑and ↓ arrow keys to set the lower portion of the vertical rectangle so that it is white, does not bounce into red, and so that the bottom portion of the image intensity profile's curve is not saturated (flattened).
6. Press [ESC] to exit the Illumination submenu and return to the Measure screen.

Adjustment Method 2

To adjust gain and offset settings using method 2:

1. From the Measure Screen, select [MENU].
2. Highlight the < or > button to adjust gain or offset.
3. Press [SELECT] repeatedly until the required amount of gain or offset is achieved.

Adjust Focus Control

If the substrate is visible through the microscope or on the monitor, but is not in focus, some adjustments may be required. This section provides instructions for adjusting both coarse and Piezo fine focus settings. Both coarse and Piezo fine focus adjust the focus offsets between objectives.

Adjust Coarse Focus

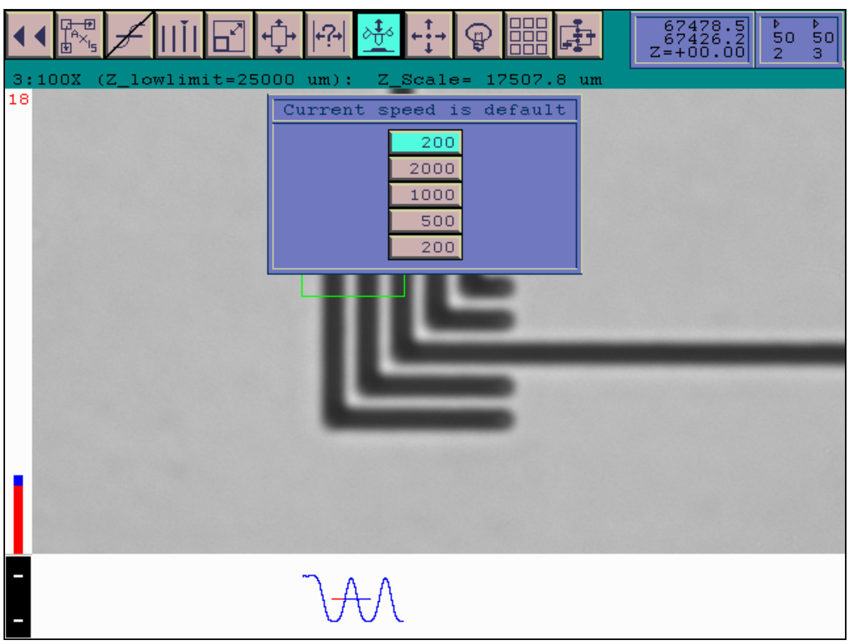
Coarse focus is accomplished with a servo motor driven column that uses a 0.1 micron linear scale for positioning repeatability. If the object cannot be focused within ±5 microns of the Piezo 0.00 position, you must adjust the column's position.

To adjust course focus:

1. From the Measure Screen, highlight the  icon and press [SELECT].
2. Press [MENU].

   The Z Motor Speed Menu subscreen is displayed (Figure 5-8).

Figure 5-8. Z Motor Speed Menu Subscreen



3. Use the ↓ and ↓ arrow keys to select a higher or slower speed, then press [SELECT].
4. Use the ↑and ↓ arrow keys to achieve coarse focus.
5. Press [ESC] to exit the Focus icon.

Adjust the Piezo Fine Focus

To adjust the Piezo fine focus:

1. To move the objective (down) closer to the substrate, rotate the keypad thumbwheel in the up direction.
2. To move the objective (up) away from the substrate, rotate the keypad thumbwheel in the down direction.

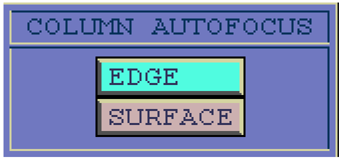
Re-center Piezo Fine Focus

To re-center the Piezo fine focus:

1. From the Measure Screen, highlight the  icon and press [MENU].

The Column Autofocus subscreen is displayed (Figure 5-9).

Figure 5-9. Column Autofocus Subscreen



2. If you are in Transmitted Illumination mode, select the [EDGE] option and press [SELECT].
3. If you are in Confocal Illumination mode, select the [SURFACE] option and press [SELECT].

Define Calibration Parameters

You should calibrate the system during initial setup. This section provides instructions for configuring system calibration settings and includes the following procedures:

- Select calibration parameters
- Calibrate the microscope
- Calibrate horizontal settings
- Calibrate vertical settings
- Configure single-point calibration
- Save calibration settings

If you plan on performing measurements with both confocal and brightfield microscopes, you will need to calibrate each objective for both of these microscopes. Since each objective must be calibrated, it is suggested that you calibrate a program setup for a specific objective (and method) and save this as a master calibration program for that objective. The master calibration program can then be copied to each subsequent program that uses that objective. This will save time and ensure program repeatability.

Once the system is calibrated, you should not need to recalibrate it unless total magnification to the camera is affected, or if the readings on the standard are outside of specifications.

How you define calibration parameters depends on the calibration standard you are using. Figures 5-11 through 5-16 show examples of setups for various types of calibration standards. The image intensity profile shown in this example is ideal because it has two black lines separated by a space. You should see this pattern on your standard in reflected illumination.

The pitch is the distance from the beginning of one line to the beginning of a second line, or from the end of one line to the end of a second line. A pitch is established when two lines are created, both lines starting with a transition from either black to white or white to black. The line may be either black or white, as long as it is surrounded on both sides by an area (or line) of the opposite polarity (color).

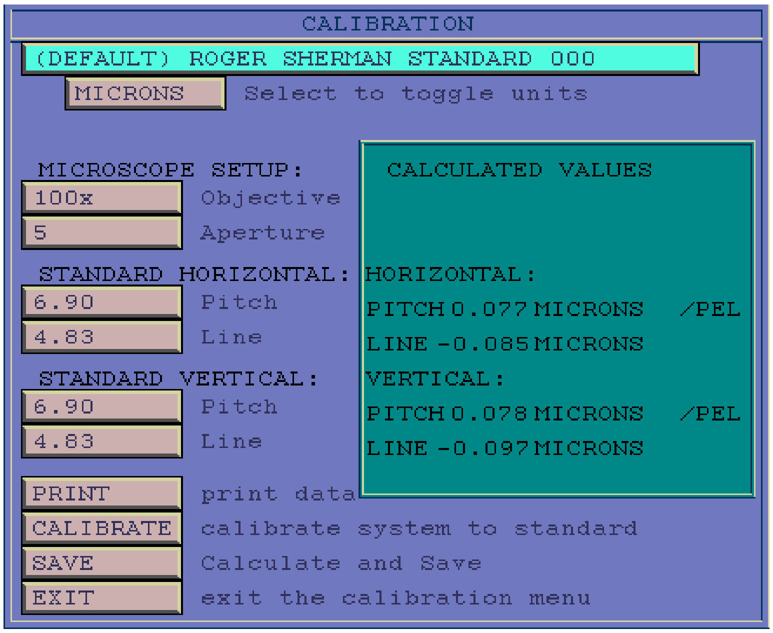
Select Calibration Parameters

To display the Calibration screen and select calibration parameters:

1. From the Supervisor Master Menu screen, highlight *Calibrate* and press [SELECT].

   The Calibration screen is displayed (Figure 5-10).

Figure 5-10. Calibration Screen



2. To change the highlighted default name, press [SELECT] and type in the name and serial number of your standard.
3. Press [ESC] to return to the Calibration screen.
4. To select your choice of measurement units as microns or micro-inches, highlight the *Select to Toggle Units* field, and press [SELECT] one or more times to toggle between microns and micro-inches.
5. Press [ESC] to return to the Calibration screen.

Calibrate the Microscope

To calibrate the microscope:

1. From the Calibrate screen, highlight the *Objective* field and press [SELECT].
2. Enter a magnification for the objective you are going to calibrate.
3. Press [SELECT] or [ESC] to set the new objective.
4. Highlight the *Aperture* field and press [SELECT].

5. Enter the size of the microscope aperture that is to be used for all measurements in this program.
6. Press [SELECT] or [ESC] to set the new aperture.

Calibrate Horizontal Settings

To calibrate the horizontal settings:

1. In the Standard Horizontal section of the Calibrate screen, highlight the *Pitch* field and press [SELECT].
2. Enter the pitch value you want to physically calibrate to.

Note: Refer to the values provided on the Standard Certification Sheet for the pitch and line size you wish to calibrate to.

3. In the Standard Horizontal section of the Calibrate screen, highlight the *Line* field and press [SELECT].
4. Enter the line dimension value.
5. Press [SELECT] or [ESC] to set the line.

Calibrate Vertical Settings

To calibrate the vertical settings:

1. In the Standard Vertical section of the Calibrate screen, highlight the *Pitch* field and press [SELECT].
2. Enter the pitch value you want to physically calibrate to.

Note: Refer to the values provided on the Standard Certification Sheet for the pitch and line size you wish to calibrate to.

3. In the Standard Horizontal section of the Calibrate screen, highlight the *Line* field and press [SELECT].
4. Enter the line dimension value.
5. Press [SELECT] or [ESC] to set the line.

Configure Single-point Calibration

This section provides instructions for configuring single-point calibration and includes the following procedures:

- Set the illumination
- Disable submicron multipoint calibration
- Set up the measurement window
- Calibrate the system to standard

Set the Illumination

To set illumination and check single-point mode status:

1. Place the measurement gauge (or standard) on the stage.
2. Focus the condenser assembly for the thickness of the standard.
3. Set the illumination with the 100x objective.

Disable Submicron Multipoint Calibration

To disable submicron multipoint calibration:

1. With the Measure screen displayed, press [ALT + O].
2. View the comment line.

Note: If *SUBM* is not displayed in the comment line, then this option is not installed and you can skip the rest of this procedure and go on to the next section.

If *SUBM* is displayed in the comment line, complete the remainder of this procedure to disable the submicron multipoint calibration function.

---

3. From the Supervisor Master Menu screen, highlight the *Program Setup* icon and press [SELECT].
4. With the Program Setup screen displayed, delete the file name displayed in the *Multipoint File Name*.
5. Highlight the *Exit* button and press [SELECT] to return to Supervisor Master Menu screen.

   Once the submicron multipoint calibration function has been disabled, `"SUBM FILE INVALID OR DOES NOT EXIST"` is displayed across the right portion of the screen.

Set Up the Measurement Window

This section provides a procedure for setting up the measurement window using any of the following three different line width standard masks:

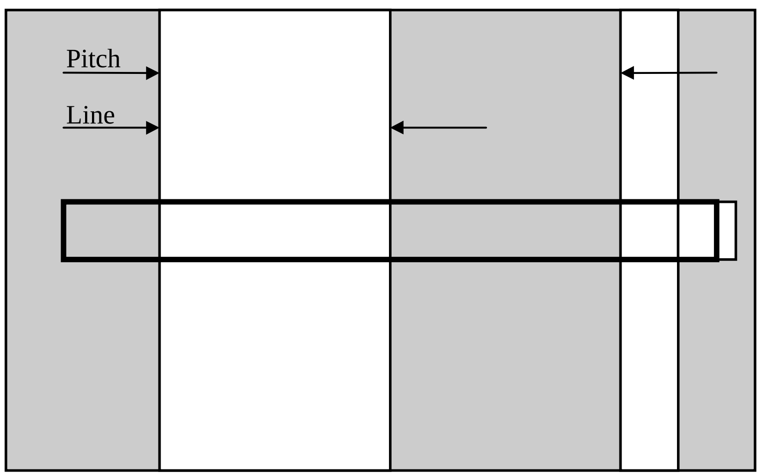
- Roger K Sherman (RKS)
- NIST SRM 473
- NIST SRM 475

1. To set up the measurement window with the Roger K Sherman (RKS) line width standard mask:

    a. Center the “L” line of Target 1 in the middle of the screen along both the X- and Y-axes.

    b. Adjust the measurement windows so that they are no higher or lower than the fiducial mark on the right side of the pitch. (Figure 5-11)

Figure 5-11. RKS standard Target 1, “L” feature



    c. Press the *Recall* button to save this window.

    d. Use the “J” line to set the measurement windows.

2. To set up the measurement window with the NIST SRM 473 line width standard mask:
   a. Center the fiducial line of target 5D on the Y-axis.
   b. Adjust the measurement windows so that they are no higher or lower than the fiducial mark on the right side of the pitch (Figures 5-12 and 5-13).
   c. Press the *Recall* button to save this window in Recall 1.

Figure 5-12. NIST SRM-473 Standard Target 5D

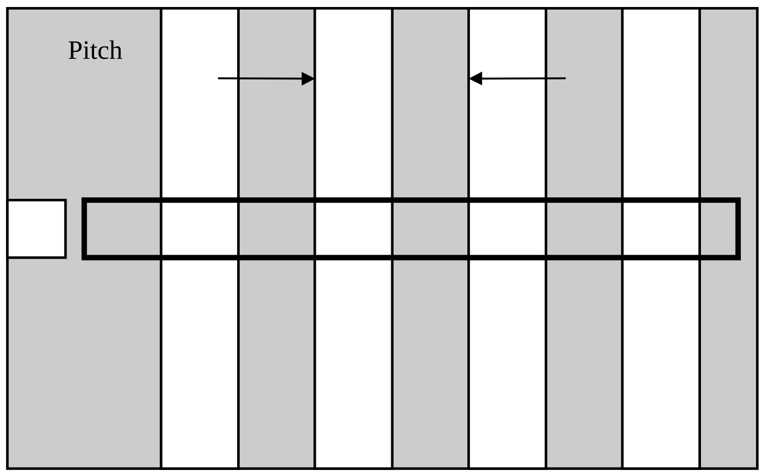
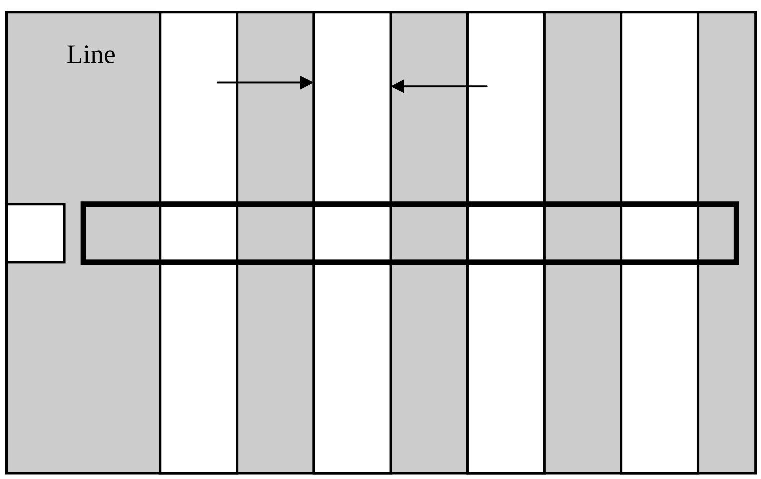


Figure 5-13. NIST SRM-473 Standard Target 5D



3. To set up the measurement window with the NIST SRM 475 line width standard mask:

    a. Center the fiducial line of Target 5 on the Y-axis.

    b. Adjust the measurement windows so that they are no higher or lower than the fiducial mark on the right side of the pitch (Figures 5-14 and 5-15).

    c. Press the *Recall* button to save this window in Recall 1.

Figure 5-14. NIST SRM-475 Standard Target 5D

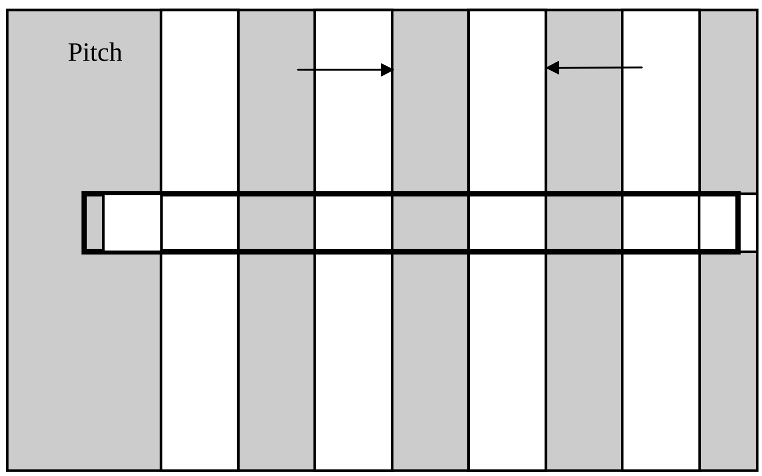
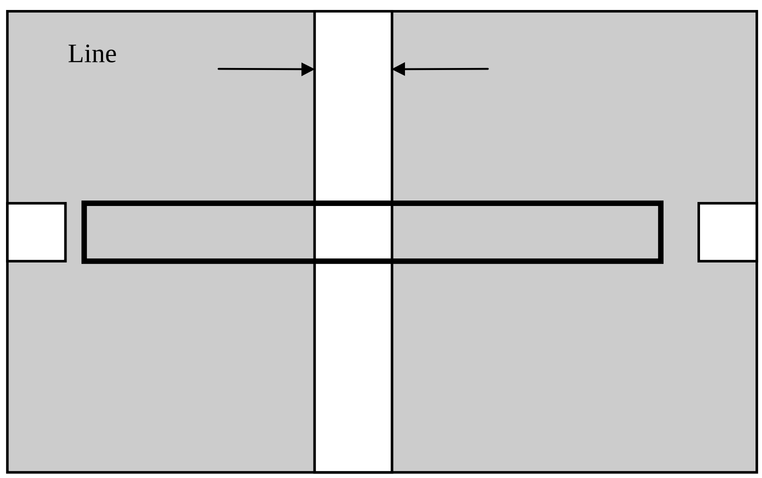


Figure 5-15. NIST SRM-475 Standard Target 5D



4. To enter the calibration standards from the Calibration Control submenu:

    a. From the Supervisor Master Menu screen, highlight the *Calibration* icon and press [SELECT].

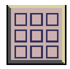
    b. Input the pitch and line values into the corresponding *Standard Horizontal* and *Standard Vertical* fields.

Calibrate the System to Standard

To calibrate the system to standard:

1. From the Calibration screen, highlight the *Calibrate* button and press [SELECT].

   The Calibration Control submenu is displayed.

2. Highlight the  icon and recall Window 1.

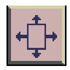
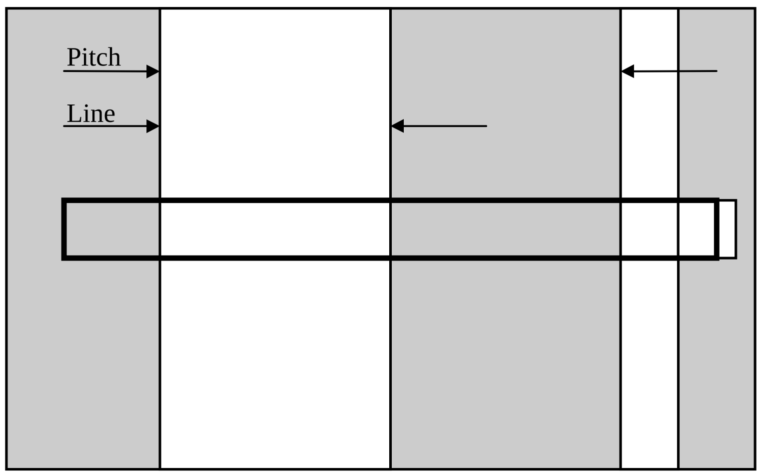
3. Highlight the  icon and move the Measure window as shown in Figure 5-16. Make sure that the correct edges are for pitch.

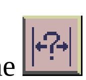
Figure 5-16. Measure Window Movement



4. Set the scan direction for measurement using the standards listed in Table 5-2.

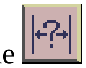
Table 5-2. Scan for Measurement Standard Directions

Standard	Left	Right
RKS	→	→
NBS	→	←
NIST	→	←

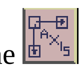
5. From the Measure screen, highlight the  icon and press [SELECT].

   The following message will be displayed in the comment line once pitch calibration is completed :

   `HORIZONTAL PITCH = =0.0567 MICORNS/PIXEL`

6. From the Measure screen press [MENU].
7. Select *Line* in the calibration submenu.
8. Make sure that the correct edges are for LINE (Figure 5-16).
9. Set the scan direction using the standards listed in Table 5-2.
10. From the Measure screen highlight the  icon and press [SELECT].

    The following message will be displayed in the comment line once line calibration is complete:

    `HORIZONTAL WHITE LINE FACTOR = 0.1097 MICORNS`
11. To save the horizontal calibration, press [ESCAPE] to return to the Calibration menu.
12. Select *Save* and press [SELECT].
13. Repeat steps 1-12 to perform vertical calibration, with the following differences.
    - Rotate the standard 90^{o} so that the line and pitch are measured in the Y-axis.
    - From the Measure screen go to the  icon and press [SELECT].
    - Set up the measurement windows as described in Steps 5, 6 and 7.
    - Follow the calibration sequence as described in Steps 8 and 9.
    - Save the vertical calibration in the Calibration menu and exit.

Save the Calibration Settings

To save the horizontal and vertical calibration settings:

1. From the Calibration subscreen, highlight *Save* and press [SELECT].

   Calibration of your program setup has now been saved and stored for use during production mode operations.
2. To return to the Calibration screen, select *Exit* and press [ESC] twice.
3. Select *Exit* and press [SELECT] to return to the Measure screen.
4. From the Supervisor Master Menu screen, highlight *Save Program* and press [SELECT].

   All window setups are now saved for this program.

Define System Options

In addition to prgam setup options, several other system options can be configured from the Supervisor Master Menu screen. This section provides procedures for changing:

- system colors
- your access code
- turret objective assignments

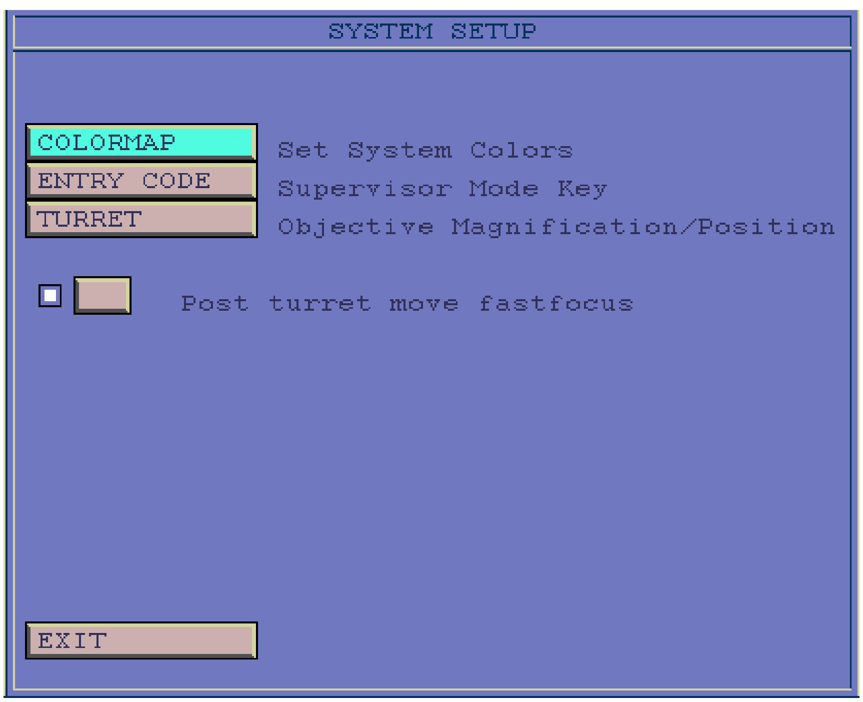
Display the System Setup Window

To display the System Setup window:

1. From the Supervisor Master Menu screen, highlight *System Setup* and press [SELECT].

   The System Setup screen is displayed (Figure 5-17).

Figure 5-17. System Setup Dialog Box



3. To return to the Supervisor Master Menu, select *Exit* and press [SELECT], or press [ESC].

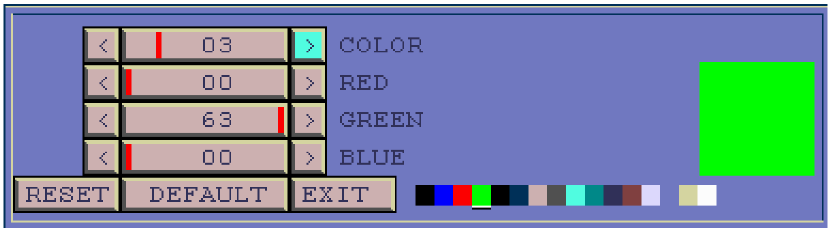
Set Map Colors

To change map colors:

1. From the System Setup screen, highlight *Color Map* and press [SELECT].

   The Color Map subscreen is displayed (Figure 5-18) below the System Setup screen.

Figure 5-18 Color Map Subscreen



2. Select the color from the palette that you want to change, highlight the *Color* button, press [SELECT] and use the arrow keys adjacent to the *Color* button to move the cursor under the color you want to change.

   The selected color is displayed on the right.

3. To select the new color you want to assign to the palette, highlight the *Red*, *Green*, or *Blue* button, press [SELECT] and use the arrow keys adjacent to the highlighted button to move the cursor under the new color you want to assign to the palette.

4. To return to the original color map settings, select *Default* and press [SELECT].

5. To undo the default settings and change the colors back to their changed settings, select *Reset* and press [SELECT].

5. To save changes to the color map and return to the System Setup screen, select *Exit* and press [SELECT].

   You can also return to the System Setup screen by pressing [ESC].

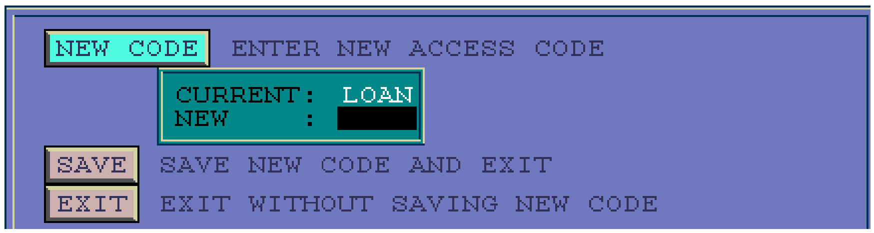
Change your Supervisor Access Code

To change your supervisor access code:

1. From the System Setup screen, highlight *New Code* and press [SELECT].

   The Access Code Subscreen is displayed (Figure 5-19) at the bottom of the System Setup screen.

Figure 5-19. Access Code Subscreen



2. To change the access code, select *New Code* and type the name of the new code using any combination of uppercase and lowercase letters.
3. To save the new code and return to the System Setup screen, select *Save* and press [SELECT].
4. To return to the System Setup screen without saving the new access code, select *Exit* and press [SELECT].

   You can also press [ESC] at any time to return to the System Setup screen.

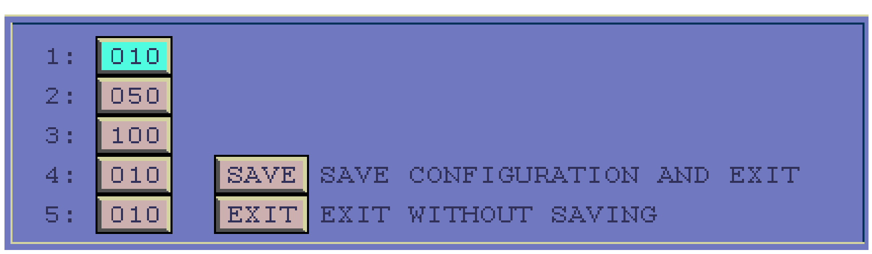
Change Objective Assignments on the Turret

To change objective assignments on the turret:

1. From the System Setup screen, highlight *Turret* and press [SELECT].

   The Turret subscreen is displayed (Figure 5-20) at the bottom of the System Setup screen.

Figure 5-20. Turret Subscreen



2. To change the magnification of the objective that will be located in this turret position:
   a. Select the turret position (1 thru 5) to be changed, type in the new magnification value and press [SELECT] to set the new value.
   b. Press [ESC] to undo the change in value.
   c. Repeat the previous steps for each turret position to be changed.
3. To save the new configuration and exit to the System Setup screen, select *Save*, and press [SELECT].
4. To exit without saving changes and return to the System Setup screen, select *Exit* and press [SELECT].

Set Objective Parfocality and Parcentricity

This section provides procedures to set the parfocality and parcentricity of either the AMS or KMS system regardless of the version of software on the system. When the user has completed this procedure the system should maintain focus and image location when moving from one objective to the next. These procedures are for AMS/KMS systems without the RIC Objective Option.

These procedures require the following materials, equipment and software:

- It is suggested that a scrap mask be used when completing this procedure.
- This procedure assumes that the illumination is properly set.
- This procedure assumes that the stage is level.

To set the parfocality and parcentricity objectives:

1. Place a mask on the mask holder.
2. Rotate the turret to the 10X objective using the key pad.
3. To set the X, Y and Z planes for subsequent turret positions:
   a. From the Measure Screen highlight the  icon, and press [SELECT].
   b. Use the ↓ arrow key to refocus on the substrate.
   c. Use the → arrow key to set the turret to position #1.
   d. Turn the substrate upside down with the chrome (or other active surface) up.
   e. Position the stage on a recognizable site and focus.
   f. Highlight and select [Reference] and press [ENTER].

   Set the z offset, z limit and parfocality for the top surface objectives.
4. Set the z offset for parfocality:
   a. Set the turret to 50X (position #2).
   b. Focus and position to a sample target.
   c. Select [Set New] and press [ENTER].

5. Set the lower z-limit for the 50X objective:

   a. Select [Set Z Limit].

   b. Use the arrow keys to adjust the z-column.

   c. Place the z-column at a lower limit of approximately 100 microns past focus (200 for ELWD).

   d. Rotate the objective toward the substrate while still above focus.

   e. Press [ESCAPE] to set the lower z-limit.

   f. Use the  icon to re-focus the target.

6. Adjust the Z-offset for parfocality:

   a. Set the turret to 100X (position #3).

   b. Focus on a selected target.

   c. Select [Set New].

7. Set the lower Z-limit for the 50X objective:

   a. Select [Set Z Limit].

   b. Use the arrow keys to adjust the Z-column.

   c. Place the Z-column at a lower limit of no more than approximately 100 microns past focus (200 for ELWD).

   d. Press [ESCAPE] to set the lower Z-limit.

8. Use the  icon to re-focus on the target.

Note: If Turret position # 4 is empty, press the ➔ arrow key once and select *Set New* to set the Z-offset to the same setting as the previous objective..

---

9. Remove the substrate and exercise the turret through its positions.

10. Exit and save the offset information to the `SYSTEM.CFG` file:

    a. Select [Save Program] to save the settings.

    b. Select [Save] during exit to dos.

    c. Backup the `system.cfg` and `system.ric` files.

Adjust Autofocus Parameters

This section provides procedures for:

- setting column autofocus
- setting the Piezo using the autofocus algorithm

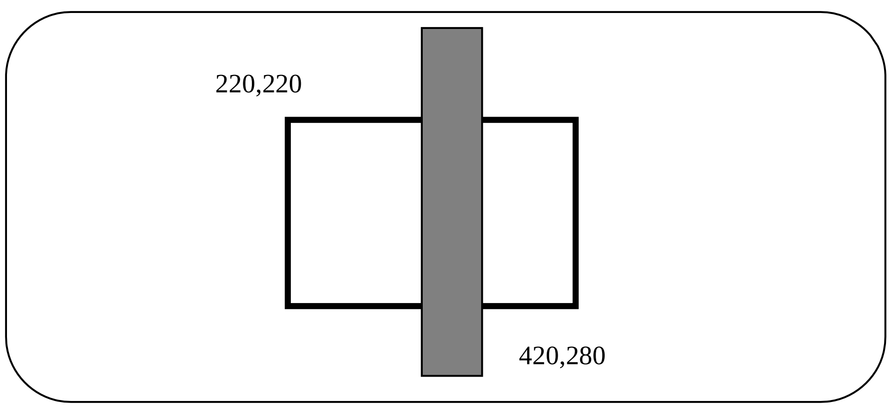
Set Column Autofocus

Before setting column autofocus parameters, make sure:

- Z is positioned inside the range of the autofocus search for the expected focus position.
- The range default is set to 20 with a step size of .1 micron.
- The default focus window (for determining the focus) is 200 pixels wide by 60 pixels high window and is in the center of the screen (Figure 5-21).
- A vertical feature is used to determine the focus inside the window (e.g. scan left to right for an edge).

Note: The focus window location and size can be changed with the script command FF_WIN. The default window is: FF_WIN: 220,220420,280.

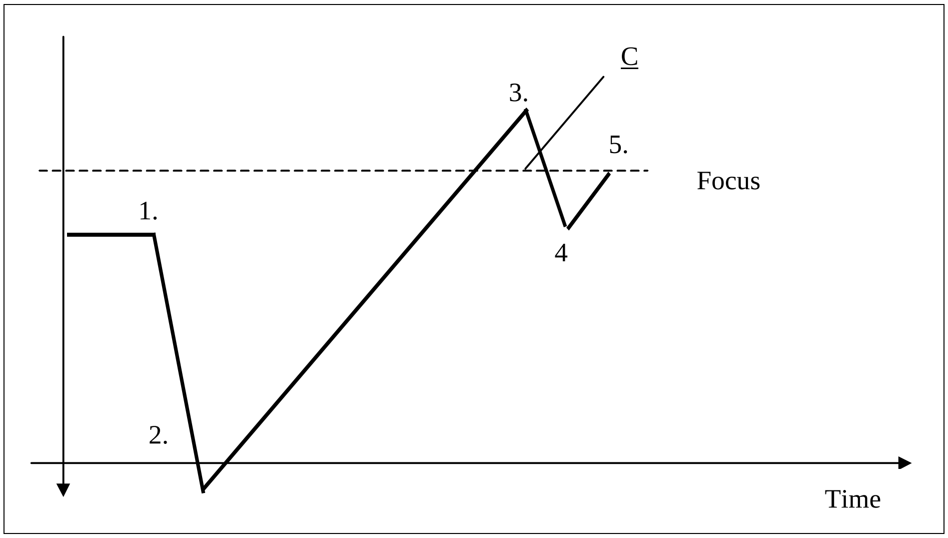
Figure 5-21. Default Focus Window



To set column autofocus:

1. Position the start of the column autofocus (Figure 5-22).

Figure 5-22. Z Positioning During Autofocus



2. Start the move to C' = ½ range offset from start. Speed allows an average of one focus reading every *step* in nanometers. (The direction of the move minimizes the effects of backlash.)

Note: Range and step can be changed with the script command FF_SET (FF_SET:20000 100) or manually with the hidden command [Alt] + [f].

---

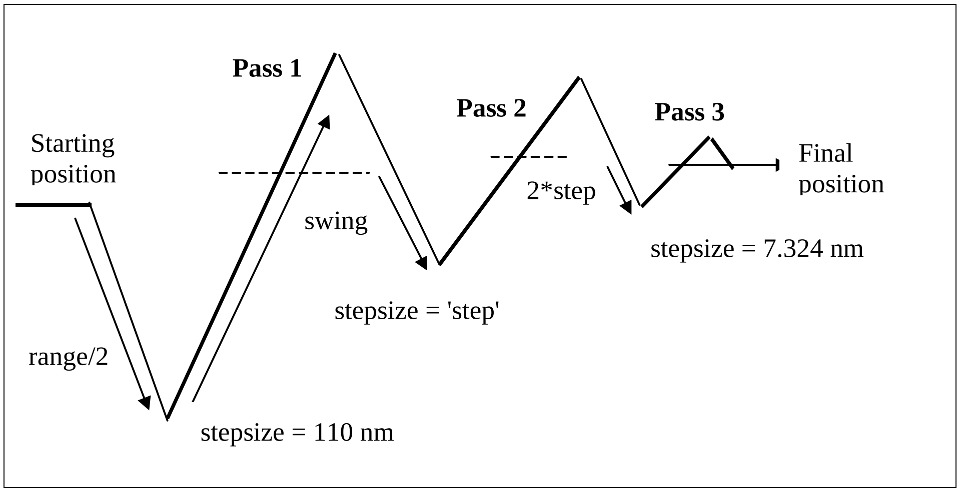
3. Stop once you have gone past the best focus position.
4. To compensate for backlash, position 1.5 microns below the best focus.
5. Jog to the best focus.

Note: The step size dictates the frequency of the readings and resulting accuracy.

Set Piezo Autofocus Algorithm

To set the Piezo using the autofocus algorithm (Figure 5-23):

Figure 5-23. Piezo Autofocus Algorithm



1. Complete a first pass (pass 1).

   Scan from start range/2 through start+ range/2 for the best focus position (p1). To do this, take a focus reading approximately every 110 nanometers (if you are using a 30 micron Piezo).

   Use Table 5-3 and the following definitions to complete the first pass (p1):

   - *Start:* initial position at the start of the autofocus procedure
   - *Range:* a user-specified parameter
   - *p1*: the best focus position

Table 5-3. Piezo Autofocus Algorithm

User Parameters	20 micron, 10 bit		30 micron, 12 bit	
	Min (nm)	Max (nm)	Min (nm)	Max (nm)
Range: total scan distance of pass 1	1000	20000	10∅0	30000
Swing: half the total scan distance of pass 2	100	15000	10∅	15000
Step: step size of scan during pass 2	10	10000	7	15000

2. Complete a second pass (pass 2).

   Scan from p1-swing through p1_swing for the best focus position (p2). To do this, take a focus reading at every user-specified step.

   Use Table 5-3 and the following definitions to complete the first pass (p2):

   - *Swing*: initial position at start of the autofocus procedure
   - *Step*: user-specified parameter
   - *p2*: best focus position

3. Complete a third pass (pass 3).

   Scan from p2-(2*step) through p2+(2*step)for the best focus position (p3). To do this, take a focus reading every 7.324 nanometers.

4. Position to p3.

6 Creating Automated Scripts

Overview

This chapter provides an introduction to the KMS-310/400 system's script capabilities and includes an overview of:

- script features
- types of commands used
- matrix file input and output concepts

Scripts are a series of system instructions saved to file that can be recalled later to automate the measurement process. Most KMS-310/400 functions can be automated using a variety of Zygo-supplied and customized scripts. With scripts, you can automate any or all measurement routines for the KMS-310/400.

Scripts are very useful in automating routine, repetitive measurements on masks or wafers that might be seen on a daily basis. A script is not as well suited for measurement of different features or parameters.

Script files are standard ASCII files, created with the DOS editor (EDIT.EXE) or another suitable editor. However, word processing programs are not considered suitable. Script files consist of a series of commands (all in uppercase) and various parameters. For a detailed listing of commands and their associated uses, refer to the *Script Locator* section of this chapter.

Script Features

This section provides a brief overview of important script features, including:

- commands
- variables and data types
- looping and control structures
- methods of input and output
- debugging aids

Script Commands

Scripts are files containing script commands. Each measure program can have an associated script file.

Each line of a script file begins with a *script command.* The script command may be:

- text
- a named variable
- a value
- a text string substitution

Script commands have the following features:

- they may be created with any text editor
- they must have `.scr` as the file extension
- they can load other measure programs, branch, loop and call script routines
- they cannot call other script files

Variables and Data Types

There are 10,000 user variables available for scripting: V0000 through V9999. These can hold an integer. There is no floating-point number representation available in scripting. The numbers are 32 bit signed integers. There is currently no support for non-numeric variables such as character strings.

Looping and Control Structures

You can implement conditional statements through looping with the use of a baked *if-then* statement. The nature of this statement is very similar to assembly language conditional structures.

Conditionals are generally implemented as a two-statement sequence: first a math statement to check an expression, then a JUMP:, LOOP:, or CALL: command. All of these statements redirect the consecutive script commands flow to a label (such as GOTO in Basic).

Used in different ways, the three commands function similarly. The general format is:

- JUMP:Vxx label
- LOOP:Vxx label
- CALL:Vxx label

Where Vxx is either a variable or a number.

If the first parameter is 0 (or false), the statement is skipped. If it is a nonzero, the command is executed and control shifts to the label. The label must be valid (up to 50 characters, excluding /,\,"or ,) and defined within the loaded script (a MARK: label command).

The JUMP: command will only look forward in the script (JUMP: Forward), while the LOOP: command jumps to the beginning of the script and continues through the script until the mark is found.

The CALL: command will transfer control to the specified label until a RETURN: command is executed. The script will then resume at the next line of the script after the CALL: command that started this subroutine. This function is analogous to the SUBROUTINE/GOSUB commands in BASIC.

Note: It is important that the CALL: Commands equals the RETURN: command, since each CALL: command puts a return address on the stack to indicate where to RETURN: to. The stack will overflow if more CALL:s are made without a corresponding RETURN: statement. A maximum of 32 calls may be imbedded within a subroutine.

The only means for branching execution is with the Vxx parameter in the commands that pass control off to another portion of the script. The variable is usually generated with a MATH: function. The MATH: function is a simple assignment function with the following format:

```
MATH:Vxx=VxyOpVxz
```

The Op value can be any one of the symbols shown in Table 6-1.

Table 6-1. Op Values

Symbol	Meaning
+	plus
-	minus
*	multiply
=	equals
/	divide
!	not
|	or
<	less than
>	greater than
SIN	sine
COS	cosine
SQRT	squareroot
&	and

The conditional operators (!, |,&,<,>,= the value assigned to Vxx) is the result of the conditional (0 or 1), corresponding to whether the VxyOpVxz is true or false. Once this is true, the Vxx can be used as a parameter to one of the control statements above to make decisions. As an example, if V01 = 6, V02 = 12, then:

```
MATH:V10=V02/V01
V10 = 2 ( 12/6 = 2)
MATH:V10=V01=V02
V10 = 0 (12 is NOT equal to 6)
MATH: V10=V01<V02
V10 = 1 (6 is LESS THAN 12)
```

The MATH: command, when paired with a JUMP: statement, allows for liberal branching within scripts.

Output

You can input and output data using either log files or matrix files.

Logfile Output

The most commonly used vehicle for outputting results is the logfile. There are two ways to set the name of the logfile. The most common method used is to have the operator enter it from the IDINFO: command. This displays the IDINFO: dialog box on the user's machine and allows the operator to change data tag settings, such as the operator ID or mask/wafer ID (part number). At the bottom of this dialog is a field to set the data log file name. The other method of setting the file name is to use a field form that is the same as the IDINFO: dialog box. For example, the field that contains the wafer ID is a good place to get a unique filename for the output log. If an extension is not specified, the three-digit program number of whatever program is in memory at the time will be used.

The PRINT: command outputs the string parameter to the logfile. To print a number you must have a string with a % in it (known as a placeholder) and follow the string with the variable to output. The program will then convert the value of the variable to a string and substitute the string value for the % in the parameter string. This is referred to as string substitution.

Matrix File Output

In addition to logfile output, you can output to a matrix file. Matrix files are rectangular arrays of numbers (integers) in a NxM grid. The matrix file can be any dimension. When you save the data in a matrix file and write it to the disk with the MATRIXWRITE: command, you create a comma-delimited file with the matrix values. This creates a convenient path to import data into a spreadsheet application such as Excel.

To use matrix files, first open the matrix with the command MATRIXOPEN:. The parameters for MATRIXOPEN: are Vhandle Vcol Vrow "Filename." All MATRIX commands require an associated Vhandle. A Vhandle is a variable that points to the open matrix and must be used for all future references to the matrix until you MATRIXCLOSE: it. You can open to 20 matrix files at one time and must not reuse the variable associated with the Vhandle until you close the matrix file. The MATRIXOPEN command opens the matrix file and reads the specified number of rows and columns into memory. If the file does not exist, a file is opened and the specified number of rows and columns are filled with the value 0. You can then use the command MATRIXSET: Vhandle Vx Vy Value to fill the matrix element by element. If you fill a matrix via the MATRIXSET: command, or merely modify elements, you will need to MATRIXWRITE: to save the values. The data remains in memory until you execute a MATRIXCLOSE: command. This releases the Vhandle and the memory used by the matrix file while it was in memory.

Input

Getting input from the user is similar to outputting data. Again, there are two basic methods of getting data from the user. You can use the MENU: command or the GETTEXT: and GETVAR: commands. The MENU input method allows you to pick from a list of choices such as type of device or features, while the GETTEXT and GETVAR methods prompt the operator to input a value or string.

MENU: Command Input

MENU: input takes a number of parameters, from two to as many as you can accommodate with 128 characters. The menu box gives the operator a list to select from. The output in the variable (the first parameter is a variable) is the index of the selection. MATH: and JUMP: commands can enable a scheme to branch to a variety of different subroutines for different substrates with a common script file.

GETTEXT and GETVAR Input

The GETTEXT: command takes just one parameter: a prompt string to notify the user of what the script is looking for. Whatever text is typed in is echoed to the logfile. This is a good way to allow the user to annotate their logfile with pertinent data for the measurement run. GETVAR: takes two parameters. The first parameter is the variable to store the results in and the second parameter is a string to prompt the user. For example, this can help a script to determine the number of iterations of measurements, all under operator control.

Debugging Aids

The KMS-310/400 scripting language offers several features to make debugging, including the:

- DEBUG: command
- OPMARK: command
- OPERATOR: command
- TEXT: command
- BOX: command
- LINE: command

The DEBUG: command, if followed with a 1 executes the script one step at a time. The SELECT (or ENTER) key is used to process each step. This allows you to view what the script is doing at each step, including what the variables are set to and what edges the RP_EXEC: finds.

Another debugging feature is the OPMARK: command. This command is similar to the MARK: command that describes a label, except that the Script menu has a button with the GOTO name on it. All OPMARK:s in the currently loaded script will be present, allowing instant access to a subroutine to speed up the debugging process.

The OPERATOR: command stops script processing and allows you to examine system parameters with the icon bar. Use this command to break execution at a specific location.

The TEXT: command prints a string to the screen at a specified point and in the color specified. Use this command to debug loops that adjust parameters such as illumination. Also, this command provides immediate feedback.

The BOX: command displays a box on the screen. Use this command to visualize where the script will be looking for its focus or RP windows. You can then identify the reason for a pattern recognition routine's failure to find the target feature and can adjust the windows to find the feature in question.

The LINE: command displays a line on the screen. Use this command to visualize where the script has located an edge in the RP_READ commands. Identification of a pattern recognition routine's success or failure can be determined and appropriate adjustments can be made.

Script Command Types

With script commands, you can accomplish most of the commands that can be executed manually, such as recall save/recall windows, set illuminations and GOSTOP:s. This section describes major script commands and how they interface with the machine.

Pattern Recognition

Pattern recognition is a scheme used to find edges in a window. There are three steps to performing pattern recognition.

1. *Set up the window (or region of interest) where you expect to find the edges.*

The command to set up the window is RP_WIN: and it takes four parameters in pixels on the screen: top left and bottom right coordinates. This will set the window on the screen that the Pattern Rec. commands look in for edges.

2. *Set up the RECPT: command.*

This takes five parameters:

- The first parameter is the pattern rec. register to use. This is a location that you can read after the pattern recognition process to determine which pixel the edge was detected under.
- The next parameter is the axis to look in. The X-axis (horizontal) is 0 and the Y-axis (vertical) is 1.
- The third parameter is the direction to look in. The positive direction is 1 and the negative direction is 0.
- The fourth parameter is the edge number. This can be any integer (within reason) to determine which edge to look for.
- The last parameter is for the threshold value as a percent. It can be a number from 1 to 100 and represents which threshold will be used to determine the "edge."

3. *Execute the pattern recognition scheme.*

Pattern recognition is accomplished with the RP_EXEC: command. It takes two parameters. The first parameter is the starting pattern "register" and the second is the number of points to execute. The number of points can be one or more, depending on how many REC_PT:s you defined. At this point, the software has the edge positions stored in the associated pattern registers. To get this information you must RP_READ: it into a variable.

For example, the following is a typical sequence of script commands to perform a pattern rec:

```
BOX:150 300 500 350 2 (Draw a box to show window)
RP_WIN:150 300 500 350 (Define the window)
RECPT:0 0 1 1 50 (define the rec_pt’s)
RECPT:1 0 1 2 50
RP_EXEC:0 2 (execute the pattern rec)
RP_READ:0 V20 (Read the locations of the edges)
RP_READ:1 V22
```

Once the edges have been found, you can set up the sequence windows. The sequence windows are where features are actually measured.

Sequence Windows

Sequence windows are very similar to pattern recognition windows, especially in how they are set up. To set up sequence windows you will set the windows. There are two windows per sequence setup, 0 and 1, which correspond with the left and right or top and bottom in vertical measurements.

After defining the sequence windows, you can define the edges to be detected. The SEQEDGE: command requires six parameters, as opposed to the five parameters required by REC_PT:

- The first SEQEDGE: command parameter is the same as the pattern register number. It specifies which sequence setup the window will be stored in.
- The second parameter defines which window (0 or 1) you are specifying. For each axis horizontal/vertical measurements, 0 is the top-left window and 1 is the bottom-right window.
- The third parameter defines the axis as 0 or 1. As with pattern recognition command RECPT: the 0-axis is horizontal and the 1-axis is vertical.
- The fourth parameter is the direction. 0 is negative and 1 is positive.
- The fifth parameter is the number of the edge to seek.
- The sixth parameter is the threshold to use for the edge derivative algorithm.

An example sequence window command code block might be:

```
SEQWIN:0 0 200 200 500 250 (Define the windows)
SEQWIN:0 1 200 200 500 250
SEQEDGE:0 0 0 1 1 50 (Define the seqedge's)
SEQEDGE:0 1 0 0 1 50 (recall the setup)
RECALL:0
```

Once you have found the feature to measure, you can create commands to enable the measurement routine.

Measurement & Reporting

Essentially, to make a measurement you find a feature, draw your seqwins, set up your seqedges and then MEASURE it.

Once you have found the feature and set the sequence windows and invoked the RECALL: command, the measurement window is displayed. Once displayed and the windows are in the correct places with the correct edges set, a measurement can be performed.

You can do several things to modify the measurement procedure. For instance, if the machine was unable to process the requested measurement, a special flag value to indicate the missed measurement may be used. The command MSR_DEFAULT: may be used to change the system default value from 99999 to a user-defined value. MSR_STATS: takes one parameter and sets which statistics register the results will be accumulated in. The default is 0, unless set under script control.

After setting MSR_DEFAULT: and MSR_STATS: you can execute the measure command. To help trap any errors, call the MSR_ERROR: command. This will put a result code into a variable parameter.

- 0 represents no error
- 1 is below limit (measurement limit set from the master menu)
- 2 is above limit
- 4 is for user-aborted (hit ESC) measurement

The MSR_ERROR: command allows you to trap measurement errors and make informed adjustments. To manipulate the reading, call the RESULTS: function. It takes two parameters. The first parameter defines which statistics register was used and the second parameter defines which variable to store it in. Once this is done, you can print the results to the log file, display it on the screen or manipulate it directly.

When measuring, the machine performs an autofocus routine by default and uses the Piezo to measure from the best focus. If you want to turn this feature off, execute the AF_STAT:0 command. This will turn off the autofocus default setting. If you want to set nonstandard range, swing or step values, execute the AF_SET: command. This command requires parameter settings for range, swing and step.

Matrix File Input and Output

Matrix files are a convenient method of inputting and outputting scripts. They are comma-delimited text (ASCII) files and have a dimension of X columns and Y rows used with the MATRIX commands. For this reason, a matrix file is a rectangular array of integers and can be quite useful for both input (as coordinates of measurement sites) and output (as a set of measurements).

Matrix files allow a flexible form of input and output to the KMS scripts. They are often used to read X and Y coordinates of features with respect to the mask origin.

Matrix Input

Before starting matrix input, make sure the machine is set up, the script has started and the ORIGIN: and DESKEW: have been set. The ORIGIN: and DESKEW: commands first set the 0,0 coordinate and then the Theta offset from stage coordinates. The MATRIX file is used to read in the X and Y coordinates of selected measurement sites.

To input a matrix file, first open the matrix file with the MATRIXOPEN: command. The MATRIXOPEN: command requires four parameters:

1. An unused variable number (V00 - V99) to act as a matrix file handle. (It is important not to use this variable for any other purpose until you close the matrix file. In general, count this variable as unavailable until the script terminates.)
2. An integer that represents the number of columns in the matrix.
3. The number of rows in the matrix file.
4. A filename for the actual matrix file. (It can also have a full DOS-qualified path.)

The format of a matrix file is a comma-delimited text file with a given number of rows and columns. If there are not enough rows in the matrix file to fill the MATRIXOPEN: request, zeros are substituted to fill the array. A sample matrix file to use in the above code fragment would be as follows:

```
-121345, 2345
-113459, 31267
21676, 11279
0, 0
```

You can add columns to the matrix to use in identifying the site for measurement, such as segment, row and die numbers. This information can then be added to the output file (or LOGFILE) to enable tracing of measurements.

Once the matrix file has been opened, place the reading value in the matrix with the MATRIXVALUE: command. The MATRIXVALUE: command requires four parameters:

1. The handle variable used to open the matrix
2. The X position
3. The Y position
4. The variable used to store the other values in

You must execute the MATRIXCLOSE: command when exiting the script to release the memory allocated to the matrix file. This frees the memory used by the matrix to the pool of available memory.

This is a sample script used to OPEN a matrix file for coordinate input. It also calls a subroutine titled SITESCAN. The SITESCAN routine actually reads the coordinates and moves to the DEFINED site.

```
//:SUBROUTINE FOR READING FEATURE COORDINATES
MARK:NANO5
MATRIXOPEN:V00 5 100 "MTX\T313SITE.MTX"
CALL:1 SITESCAN
MATRIXCLOSE:V00
JUMP:1 EXITMARK

//:SUBROUTINE FOR MOVE FROM ONE SITE TO ANOTHER
//:MAKE V01 AS THE CURRENT ROW # IN THE MATRIX AND START
FROM ROW #1
//:WITH THE MATRIX OPENED, READ THE MATRIX COLUMNS

MARK:SITESCAN
MATH:V01=0
MARK:NEXTPOS
MATH:V01=V01+1
MATRIXVALUE:V00 1 V01 V02
MATRIXVALUE:V00 2 V01 V03
MATH:V15=V02=0
JUMP:V15 EXITSCAN
MOVEPOLZ:V02 V03
PAUSE:2
CALL:1 MEASURE
PRINT:"% ",V88
LOOP:1 NEXTPOS
MARK:EXITSCAN
RETURN:
```

The last RETURN: command returns control to the calling code, which then performs a MATRIXCLOSE: command to free the memory used by the matrix.

Matrix Output

Matrix files can be used to output data in a format that can be placed directly into any other program that can import CSV (Comma Separated Value) or Matrix format files (such s Excel). This enables you to reduce a series of measurements to a MATRIX and then easily import them into an analysis program. The CSV file extension may substitute for the MTX file extension.

The first step in outputting matrix files is to set up the matrix files and their associated *handles*. The handle is a variable that is used by subsequent commands to point to the matrix in memory. The handle is the only reference to the matrix in use. If the handle variable is used for anything else while the matrix is open, the matrix and all the values associated with it will be lost.

Do not use the handle variable for anything until the MATRIXCLOSE: command has been executed on it. Otherwise, memory for the matrix will continue to be allocated and eventually, if enough matrixes are orphaned, the system will run out of memory for script usage. Orphaned matrix problems are very difficult to diagnose.

In the first block of sample code below, three matrix files are being created. Each of these files is set for 10x10 (ten sets of ten measurements). The script also uses the MATH: and LOOP: commands to loop through these ten sets of ten and three features.

```
//:SETTING UP THE 3 MATRICES TO STORE DATA
MATRIXOPEN:V60 10 10 "C:\300LC\LINE.MTX"
MATRIXOPEN:V70 10 10 "C:\300LC\SPACE.MTX"
MATRIXOPEN:V80 10 10 "C:\300LC\PITCH.MTX"
```

The second block of sample code below sets the two loops that will iterate through the ten sets of ten measurements. The data will be stored in columns. The code calls first for ten readings down, then a move to the second set of ten in the second column, etc. The loop variables will be used to index into the matrix to store the readings.

```
//: BIG LOOP OF TEN MEASUREMENTS
MATH:V90=0                V90 will represent the COLUMN in
                          the matrix
MARK:X_REPEAT             or the X coordinate
MATH:V90=V90+1
//: SMALL LOOP OF TEN MEASUREMENTS
MATH:V50=0                V50 will be the ROW in the
                          matrix
MARK:Y_REPEAT             or the Y coordinate
MATH:V50=V50+1
```

Now we assume that we are at a measurement site and the script executes the measurement routine. The MATRIXWRITE: command is optional, but it allows the script to be stopped without losing accumulated data. If it is not done after the MATRIXSET: command, you must do it after the loops are finished and before the MATRIXCLOSE: command. The MATRIXWRITE: command sends the data to the DOS location called out in the MATRIXOPEN: command. In the following example, the result is stored in the measure register #0.

```
//:PUT MEASUREMENT INTO LINE MATRIX
RESULT:0 V61
MATRIXSET:V60 V90 V50 V61
MATRIXWRITE:V60 "C:\300LC\LINE.MTX"
```

The other measurements (space and pitch) are coded exactly as the previous code set, with different matrix handles and filenames.

You can also change the value of a matrix location by using the MATRIXSET: command. This command is similar to the MATRIXVALUE: command, except it outputs the variable into the matrix location instead of reading it into a variable. (Keep in mind that, at this point, it is not saved to the disk yet).

To save a matrix file created or modified with MATRIXSET:, execute the MATRIXWRITE command. This writes the matrix in memory to the file indicated with the MATRIXOPEN: command.

The following example code block illustrates the LOOP: structure, as well as the final MATRIXCLOSE: block that releases the “handle” variables and the memory back to the pool.

```
//:SMALL LOOP COUNTER
MATH:V51=V50<10          Do 10 small loops for each
                         iteration
LOOP:V51 Y_REPEAT        of the large loop

//:LARGE LOOP COUNTER
MATH:V91=V90<10          Repeat the LARGE loop 10 times
LOOP:V91 X_REPEAT

MATRIXCLOSE:V60          Close and release the memory
                         allocated
MATRIXCLOSE:V70          to the three matrix files used
                         for output.
MATRIXCLOSE:V80
EXIT:
```

Once this sample script is finished, there will be three matrix files in the C:\300LC directory. Each of these files will be a 10x10 CSV format file with data series in columns and ready for export.

Script Creation

Overview

The basic steps you will take to create a script include:

1. Plan the script.
2. Locate edge features.
3. Set up align and deskew parameters for the mask.
4. Set up planarity for the mask.
5. Obtain substrate information.
6. Move to the features to be measured.
7. Call the measurement subroutine.
8. Suggest order of script sequence.

Plan the Script

The best scheme for creating a script is to first visualize the device (or feature) on a sheet of paper. As you draw the device roughly to scale:

- Draw the windows to set up the sequence windows for feature measurement in the X-, Y- or Z-axis.
- Imagine how the part will be found if the stage does not position it correctly.
- Identify any distinct features to look for as a pattern recognition routine that can assist in centering the part.

Locate Feature Edges

Use pattern recognition to find the top, bottom, left and right edges of the feature. First, calculate the centroid of the feature. Next, calculate the offset from screen center. Finally, try to center the feature on the screen using RELMOVE: commands.

Once the feature is centered, use pattern recognition again to get the new top, bottom, left and right edges. This will enable you to set up the sequence windows for measuring the line, space and pitch. Be careful to set the windows near a fiducial so that the measurement windows can be located accurately and consistently.

It is recommended that you set up this portion of the script using an OPMARK: command. This facilitates testing the measurement/pattern recognition feature centering commands and enables a quick edit/run/debug mode (reducing cycle time).

Once the measurement subroutine is stable and robust, you can set up the script.

Set Up Align and Deskew for the Mask

The align and deskew of the mask is typically accomplished by using GOSTOP: locations to center alignment marks. Start the script at 10x (or the lowest available magnification) and pause the script (with either an OPERATOR: or MENU: command) while prompting the user to align and focus. The origin should be a feature that is distinct and easy to locate. The DESKEW mark should be as far away from the ORIGIN as possible, and be in the same "row" as the origin in order to set the angular offset between the mask and stage coordinates.

Set Up Planarity for the Mask

The planarity for the mask or wafer is typically set using the ORIGIN and DESKEW points with a third point as far away as possible from them. These three points are used by the software to calculate a plane of the substrate that can be used to adjust the Z-height when the stage is moved to a particular location. This is crucial in confocal mode, where the depth of focus is measured in tens of nanometers. To set up mask planarity, it is recommended that you execute a PLANEPT:[1|2] after each of the origin/deskew commands, then have a GOSTOP: set to a point approximately 60 degrees from each of them. This will be PLANEPT:3. Once you execute PLANECALC:, the plane of the substrate will be calculated and used in all future MOVEPOLZ: commands.

Obtain Substrate Information

Use the IDINFO:O command to display the substrate information menu to the operator. This display allows operators to identify themselves, the mask or wafer being measured, individual features to be measured, as well as set the logfile name where all data will be printed. This is important to ensure that the data generated can later be traced to the substrate in question.

Move to Features to be Measured

There are two methods for moving to the features to be measured: using GOSTOP:s or reading the coordinates from MATRIX files. For some situations, GOSTOP:'s are adequate. They are simple to set and implement in the script. However, GOSTOP:s have limits. There are only 100 GOSTOP:s available for each program, and each one has to be set manually. In larger sets of measurements, MATRIX files are recommended. They allow flexibility (since it is easy to add sites to a matrix file) and other data tags to be stored in the matrix file (such as index or die numbers) to identify the feature/site being measured.

Call the Measurement Subroutine

Finally, call the measurement subroutine to perform the measurement. The results will then be printed directly to the logfile or returned for formatting. Several measurements can be executed per site. In this case, the data can be arranged by column in the logfile.

Suggested Order of Script Sequence

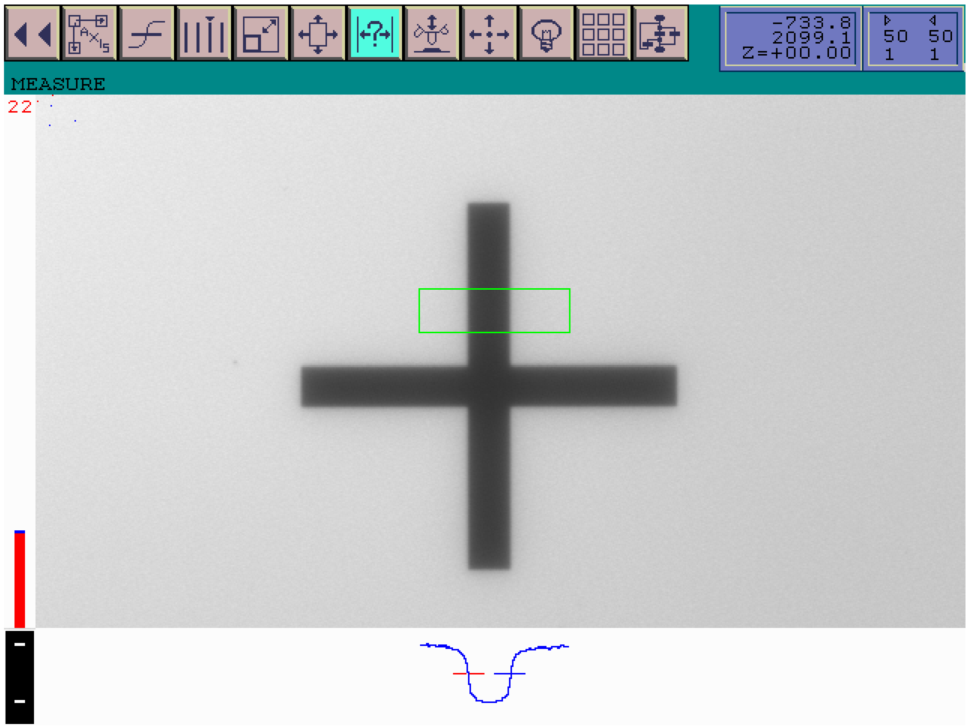
The suggested order for script subroutines is as follows:

- Align, deskew (and planarize the mask)
- Open input files
- Open output files
- Start loops/counters
- Move to feature to be measured
- Pattern recognition routines
- Measure and output data
- Ceck loop counter
- Close output files
- Exit

Example Script

This section shows an example script designed to measure the upper and righthand element of the cross (Figure 6-1). Specific sections of the script and their functions are noted as part of the script.

Figure 6-1. Measurement Scenario for Example Script



Example Script

```
//:THIS IS AN OUTLINE FOR A BASIC SCRIPT THAT WILL MEASURE THE
//: UPPER ELEMENT AND THE RIGHT HAND ELEMENT OF A CROSS

//:VARIABLES
//:    000-099 - BASE SCRIPT
//:    100-199 - ALIGNMENT PROCEDURE
//:    200-299 - MATRIX INPUT / OUTPUT / COUNTERS
//:    300-399 - STAGE MOVEMENT
//:    400-499 - PATTERN RECOGNITION
//:    500-599 - SEQUENCE / MEASUREMENT / STATISTICS
//:    600-699 - GENERAL MATH
//:    >700 - OPEN
```

```
//:BASIC ORDER OF EXECUTION
//:   PLATE ID / LOGFILE OPENING
//:   ALIGNMENT PROCEDURE
//:   MOVE TO FIRST FEATURE
//:   CENTER FEATURE AND PATTERN RECOGNITION
//:   CONSTRUCT MEASUREMENT WINDOWS AND MEASURE
//:   OUTPUT MEASUREMENTS
//:   END SCRIPT

//:**************************************************************
//:OPENS IDINFO SCREEN, PRINTS INFORMATION TO NAMED LOGFILE
//:TURNS PRINTER ON
//:TURNS STATISTICS ON AND CLEARS REGISTERS

IDINFO:O
IDINFO:P
   MENU: V99 "TURN PRINTER ON?", YES, NO
      MATH: V98=V99=1
            PRINTER: V98
   MENU: V99 "TURN STATISTICS ON?", YES, NO
      MATH: V97=V99=1
            STATS: V97
            STATS: C
//:**************************************************************
//:ALIGNS MASK TO USER DEFINED ORIGIN, DESKEW AND PLANARIZATION
   POINTS
//:USER MUST PRE-DEFINE IN THIS SCRIPT THE ORIGIN, DESKEW AND
   PLANEPT-3
//:IN MICRONS  PRE-DEFINE THE ORIGIN MANUALLY IN THE STAGE ICON
   MENU
//: ALL MOVEMENTS ARE IN POLAR (MASK) COORDINATES

MOVEPOL: 0 0
XHAIR:
MENU: V199 "MOVE FEATURE TO CROSS HAIR"
ORIGIN:
PLANEPT:1

MOVEPOL: x1 y1  (Coordinates for DESKEW point must be entered at
   this point)
XHAIR:
MENU: V199 "MOVE FEATURE TO CROSS HAIR"
DESKEW:
PLANEPT:2
ERASE:
```

```
MOVEPOL: x2 y2  (Coordinates for PLANEPT3: point must be entered
   at this point)
MENU: V199 "FOCUS FEATURE"
PLANEPT:3
PLANECALC:
//:****************************************************************

MATRIXOPEN: V200 2 20 "C:\300LC\MTX\CROSSIN.MTX"
   MATH: V201 = 0
      MARK: COORD_LOOP
   MATH: V201 = V201 + 1
      MATRIXVALUE: V200 1 V201 V301
      MATRIXVALUE: V200 2 V201 V302
            MOVEPOL2_NUM: V301 V302
      CALL: 1 CENTER
      CALL: 1 URCROSS
      CALL: 1 MEASURE
   MATH: V202 = V201 < 20
      LOOP: V202 COORD_LOOP
   MATRIXCLOSE: V200
   TURRET: 1
   POSMOVE: 65000 65000
   EXIT:

//:****************************************************************
//:MEASURES THE UPPER LEG AND RIGHT ARM OF A CROSS FEATURE
//:OUTPUTS VALUES FOR SEQUENCE WINDOWS 3UM BEYOND EDGES OF
   FEATURE
//:CENTERS FEAURE BASED ON +/- 2UM STAGE ACCURACY
//:"MARK" ALLOWS FOR MULTIPLE "CALL:'s" OF THIS ROUTINE

MARK: CENTER
//:CENTERING ROUTINE
   RP_WIN: 140 60 500 420
      BOX: 140 60 500 420 2
   RECPT: 1 0 1 1 50
   RECPT: 2 0 0 1 50
   RECPT: 3 1 1 1 50
   RECPT: 4 1 0 1 50
      RP_EXEC: 1 4
   RP_READ: 1 V401
   RP_READ: 2 V402
   RP_READ: 3 V403
   RP_READ: 4 V404
      ERASE:
//:  X-AXIS MOVE TO CENTER CALCULATION
      MATH: V410=V401+V402
      MATH: V410=V410/2
      MATH: V410=V410-320
      MATH: V410=V410*50
//:  Y-AXIS MOVE TO CENTER CALCULATION
      MATH: V411=V403+V404
      MATH: V411=V411/2
      MATH: V411=240-V411
      MATH: V411=V411*50
//: CENTERING MOVE IN 0.1UM RESOLUTION
   RELMOVE_NM: V410 V411
   RETURN:
   MARK: URCROSS

//:PATTERN RECOGNITION FOR MEASUREMENT
   RP_WIN: 230 150 410 330
      BOX: 230 150 410 330 2
   RECPT: 1 0 1 1 50
```

```
   RECPT: 2 0 0 1 50
   RECPT: 3 1 1 1 50
   RECPT: 4 1 0 1 50
      RP_EXEC: 1 4
   RP_READ: 1 V401
   RP_READ: 2 V402
   RP_READ: 3 V403
   RP_READ: 4 V404
//:  BUILDING X AXIS MESUREMENT BOX
//: X COORDINATES
      MATH: V421=V401-60
      MATH: V422=V402+60
//:Y COORDINATES
      MATH: V423=V403-80
      MATH: V424=V403-40
//: SET X/Y COORDINATES TO SEQWIN COORD VARIALBLES
   SEQNAME: 0 “UPPER X”
      MATH: V521=V421
      MATH: V522=V422
      MATH: V523=V423
      MATH: V524=V424
//:  BUILDING Y AXIS MESUREMENT BOX
//: X COORDINATES
      MATH: V431=V402+40
      MATH: V432=V402+80
//:Y COORDINATES
      MATH: V433=V403-60
      MATH: V434=V404+60
//: SET X/Y COORDINATES TO SEQWIN COORD VARIALBLES
   SEQNAME: 1 “RIGHT Y”
      MATH: V531=V431
      MATH: V532=V432
      MATH: V533=V433
      MATH: V534=V434
//:****************************************************************
   MARK: MEASURE
//: SETS SEQUENCE WINDOWS AS PER THE CHOSEN PATTERN RECOGNITION
   ROUTINE
//: MEASURES BOTH X AND Y
//: SETS STATISTICS REGISTERS TO X=0 / Y=1
//: PRINTS STATS IF OPTION IS CHOSEN IN IDINFO SCRIPT

//: X AXIS MEASUREMENT SEQUENCE
   SEQWIN: 0 0 V521 V523 V522 V524
   SEQWIN: 0 1 V521 V523 V522 V524
      SEQEDGE: 0 0 0 1 1 50
      SEQEDGE: 0 1 0 0 1 50
            MSR_STATS: 0
      RECALL: 0
   MEASURE:
      RESULT: 0 V530
            CALL: V98 PRINT_EA_X
      STATMSR3: 0 V531 V532 V533 V534 V535
            CALL: V97 PRINTX
//: Y AXIS MEASUREMENT SEQUENCE
   SEQWIN: 0 0 V531 V533 V532 V534
   SEQWIN: 0 1 V531 V533 V532 V534
      SEQEDGE: 0 0 1 1 1 50
      SEQEDGE: 0 1 1 0 1 50
            MSR_STATS: 1
      RECALL: 1
   MEASURE:
      RESULT: 1 V540
            CALL: V98 PRINT_EA_Y
```

```
      STATMSR3: 1 V541 V542 V543 V544 V545
            CALL: V97 PRINTY

//:PRINT MEASUREMENT AND STATISTICS

MARK: PRINT_EA_X
   PRINT: "X Measurement=%, V530
RETURN:

MARK: PRINT_EA_Y
   PRINT: "Y Measurement=%", V540
RETURN:

MARK: PRINTX
   PRINTSTR: " X Axis - Avg= %, Max=%, Min=%, 3 StDev=%, n=%",
   V531,V532,V533,V535,V534
   PRINT:
RETURN:

MARK: PRINTY
   PRINTSTR: "Y Axis - Avg= %, Max=%, Min=%, 3 StDev=%, n=%",
   V541,V542,V543,V545,V544
   PRINT:
RETURN:
```

Script Locator

Use the Script Locator reference tables in this section to find the location within this chapter for definitions of specific script commands. If you know the name of the script command, use Table 6-2 to identify a page number within this chapter for specific information about the command. If you do not know the script command name, but do know what type of function it serves, use Tables 6-3 through 6-20 to identify a page number within this chapter for specific information about the command.

Listing by Alphabetical Order

Table 6-2 lists all script file commands in alphabetical order.

Table 6-2. Alphabetical Summary List of Commands (Part 1 of 8)

Script Name	Function	Page Number
AF_EXEC	Execute autofocus.	6-48
AF_SET	Set up range, swing and step in PIEZO units.	6-48
AF_STAT	Turn Autofocus on or off (1/0) Turn AF on or off measurement	6-48
ALIGN	Set current position as *align* point for subsequent DESKEW.	6-49
BOX	User defined on screen graphic Vx1 Vy1 Vx2 Vy2 Vcolor [Vfilled]	6-49
CALL	Call subroutine MARKER.	6-49
CLEARPIC	Erase the displayed picture.	6-50
CLOCK	Used to record DOS clock [Vmth Vdy Vyr]/T[Vhr Vmn Vsc];P=log DATE+TIME,D=DATE/T=TIME to Vnums	6-50
COMMENT	Allows non-command input in script	6-50
DEBUG	Allows for single stepping of script	6-51
DESKEW	Set the 'polar' angle for stage to mask coordinate system conversions.	6-51
EDGES	Optional command to measure oblique features	6-53
EDGEPOS	Optional command to measure relative position of two edges	6-53
EDGEROUGHNESS	Optional command to measure edge roughness	6-54
END	End script execution and restart.	6-55

Table 6-2. Alphabetical Summary List of Commands (Part 2 of 8)

Script Name	Function	Page Number
ERASE	Erase screen and redraw windows/realtime.	6-55
EXIT	End script execution and restart.	6-55
FASTSURF	Find surface in confocal mode.	6-55
FF_SET	Set course focus range and step.	6-56
FF_WIN	Set course focus window.	6-56
FINDSURF	Find surface in RP_WIN.	6-56
FOCUSFAST	Perform fast piezo focus.	6-57
FOCUSIMG	[flg1 [flg2]]; if flg1 use FF_SET parameters. flg2: 0=surf 1=edge Column focus, will reset piezo to center of stack	6-57
GETMOTCNTS	Get the motor position (not scales!) in um.	6-57
GETPOS	Get stg position in 1.0 um resolution.	6-57
GETPOS_NM	Get stg position in 0.1 um resolution.	6-57
GETSTOP	Get (aligned) coordinates of STAGE STOP.	6-58
GETTEXT	Get a text string from the user and send to log file.	6-58
GETVAR	Get number from user and put in Vnum.	6-58
GETWIN	Get screen position of measure window.	6-59
GET_MOT_Z	Column position (units are .001 um)	6-60
GET_Z	Piezo position (units are .001 um)	6-60
GO_ORIGIN	Move stage to 'polar' origin.	6-60
GOSTOP	Go to GOSTOP number Vstop.	6-60
GRABSTAT	Acquisition of video images	6-61
GSPAWN	Execute DOS command with parameter while in graphics mode.	6-61

Table 6-2. Alphabetical Summary List of Commands (Part 3 of 8)

Script Name	Function	Page Number
INCLUDE	Insert a script segment from an existing file	6-62
IDINFO	Manipulate input to log file.	6-63
JUMP	Jump forward to MARKER.	6-64
LINE	User defined screen graphic to draw a line	6-64
LOADCALIB	Load calibration file.	6-64
LOADCF	Load "correction factor" calibration file.	6-65
LOADPROG	Load program Vnum.	6-65
LOADSUBM	Load filename of multipoint calibration data file.	6-65
LOCKOUT	Locks the OPERATOR out of ESCAPEing from script processing	6-66
LOGMEASURE	Turns the measure logging on and off	6-66
LOOP	Loop back to MARKER.	6-66
LUMAUTO	Adjusts system illumination to approximate LUMMARK values	6-67
LUMAVG	Averages the number of frames as setup in the program for image analysis	6-67
LUMDUMP	Dump illumination data of SEQWIN0 as comma-delimited data.	6-67
LUMMARK	Sets default values for illumination when used with LUMATUO	6-68
LUMREAD	Reads current illumination settings	6-68
LUMSET	Sets illumination via script	6-68
MAPMENU	[N filename]|[C Vdimx Vdimy]|[S Vscale] | [D] | [PD PS PV]. Display matrix output as a data map.	6-69
MASK_ORIGIN	Set mask coordinate origin at current position or Vx Vy nms stage coordinates.	6-69

Table 6-2. Alphabetical Summary List of Commands (Part 4 of 8)

Script Name	Function	Page Number
MASK_PLANE	VxM1 VyM1 VxM2 VyM2 [VxM3 VyM3]; align/deskew and planecalc	6-70
MARK	Set MARKER label for CALL, JUMP and/or LOOP.	6-71
MATH	Vnum = V1 [op V2] ;op î +,-,*,/,<,>,=,!,|,&,SIN,COS,SQRT.	6-71
MATRIXCLEAR	Clears all matrix files in memory that are open	6-72
MATRIXCLOSE	Close MATRIX Vhandle (frees memory + handle).	6-72
MATRIXOPEN	Open MATRIX, with dimension = x*y.	6-73
MATRIXSET	Set MATRIX value Vhandle (x,y) to Vnum.	6-74
MATRIXVALUE	Get MATRIX value Vhandle (x,y) in Vnum.	6-74
MATRIXWRITE	Save MATRIX file as 'file.ext' (default: opened name).	6-75
MEASURE	Involves measurement of feature	6-76
MEASUREALGORIT-HM	Allows switching between standard measure/focus algorithm and average/min-max algorithm	6-76
MENU	Allows pop-up menu with selections for operator	6-76
MESSAGE	Put 'text string' on message line.	6-77
METER	Place light intensity of RP_WIN into Vnum (1024 MAX).	6-77
MOT_Z_MOVE	Move to column position (units are .001 um).	6-77
MOT_Z_REL	Relative move to column position (units are .001 um)	6-78
MOVEPOL	Move to 'polar' x/y coordinates in 1.0 um resolution (in aligned + deskewed space).	6-78
MOVEPOL_NM	Move to 'polar' x/y @ 0.1 um resolution (in aligned + deskewed space).	6-79
MOVEPOLZ	Move to 'polar' x/y coordinates with Z compensation in 0.1 um resolution.	6-79
MOVEPOLZ_NM	Move to 'polar' x/y coordinates with Z compensation in 0.1 um resolution.	6-80

Table 6-2. Alphabetical Summary List of Commands (Part 5 of 8)

Script Name	Function	Page Number
MSR_DEFAULT	Value for RESULTS if there is an error in the measure	6-80
MSR_ERROR	Gets flag for sequence Vseq. (0:none,1:+,2:-,3:?,4:user abort)	6-81
MSR_STATS	Set collector for gathering of standard measurement statistics (max=10).	6-81
OPERATOR	Gives control to operator until ESC	6-81
OPMARK	Marker used for debugging script	6-82
ORIGIN	Sets (0,0) for aligned space to current pos	6-82
PATREC_FIND	Find an image pattern matching model.	6-83
PATREC_GET	Retrieve results pattern match.	6-84
PATREC_SAVE	Save image of feature for PATREC_FIND command use.	6-85
PATREC_SHOW	Show a saved image.	6-85
PAUSE	Pause script execution for Vseconds seconds.	6-86
PICSHOW	Load saved image + put upper-left at (Vx,Vy).	6-83
PICTURE	Vx1 Vy1 Vx2 Vy2 "fname"; save image to 'fname' (as '.BMP' file) (not for pattern recognition).	6-86
PICTURETIFF	Save VIDEO image to 'fname' (as'.TIF'file) (not for pattern recognition).	6-86
PICTUREVGA	Save VIDEO + OVERLAY to 'fname' (as '.BMP' file) (not for pattern recognition).	6-86
PLANECALC	Calculate planarization values for MOVE_POLZ commands.	6-87
PLANEPT	Set points to define surface plane (for 'planar-polar' coordinates).	6-87
POSMOVE	Move to nonaligned stage x/y coordinates in 1.0 um resolution.	6-87

Table 6-2. Alphabetical Summary List of Commands (Part 6 of 8)

Script Name	Function	Page Number
POSMOVE_NM	Move stage to nonaligned x/y coordinates in 0.1 um resolution.	6-88
POSPOL	Get 'polar' position in x/y coordinates @ 1.0 um resolution.	6-88
POSPOL_NM	V_x V_y ; get 'polar' position in x/y coordinates @ 0.1 um resolution	6-88
PRINT	"Text string" to log file	6-88
PRINTER	Logged data is echoed to printer.	6-88
PRINTSTR	Print "string" without CR/LF. (Follow command with PRINT: command.)	6-88
PROGNUM	Get the number of the active program.	6-89
QUIT	End script execution and restart.	6-89
RECALL	Call a pre-set measurement setup from either manual settings or sequence settings. Can displace upper left corner of left window x/y pixels.	6-89
RECPT	Defines edge to be located in pattern recognition routine	6-90
RELMOVE	Move stage a relative x/y distance from current position in 1.0 um resolution.	6-90
RELMOVE_NM	Move stage a relative x/y distance from current position in 0.1 um resolution.	6-90
REL_POL	Move stage a relative x/y distance in 'polar' space with 1.0 um resolution.	6-90
REL_POL_NM	Move stage a relative x/y distance in 'polar' space with 0.1 um resolution.	6-91
REL_POLZ	Stage relative in 'planar-polar' space (Z compensation) with 1.0 um resolution	6-91
REL_POLZ_NM	Stage relative in 'planar-polar' space (Z compensation) with 0.1 um resolution	6-91
RESULT	Put results of measurement register into a variable	6-91
RETURN	Return from CALLed subroutine.	6-92
RP_DISPLAY	For DEBUG purposes; shows RP_WIN summed data	6-92
RP_EXEC	Vstart Vcnt ;Vstart=Vptnum Do Ptrn Rec fr Point Vstart for Vcnt Points. Executes RECPT command for pattern recognition	6-92

Table 6-2. Alphabetical Summary List of Commands (Part 7 of 8)

Script Name	Function	Page Number
RP_READ	Get result from pattern recognition search.	6-92
RP_WIN	Vx1 Vy1 Vx2 Vy2; (upper left, lower right). Set pattern recognition window. Defines area of search for edge detection pattern recognition routine.	6-92
SEQEDGE	Defines edge(s) for measurement sequence setup. Vseq[0-9] Vwin[0,1] Vaxis[H=0,V=1] Vdir[PLUS=1,NEG=0] Vedge[1-100] Vth	6-93
SEQNAME	Set the name of measure sequence.	6-94
SEQOUTPUT	Select measurement output type; mean, maximum, or minimum.	6-94
SEQWIN	Defines windows for measurement sequence setup	6-94
SETSTOP	Set stop to V_x, V_y in coordinate system (in 1 microns).	6-95
SHOWPIC	Load saved image to display screen.	6-95
SILENT	Toggles on and off if the interpreted commands will be echoed to screen	6-95
SITENAME	Set the measure site name to 'name'.	6-95
SPAWN	Execute DOS command with parameters.	6-95
START	Restarts the script from the beginning	6-96
STATEDGE	Measure edge statistics in subpixel values.	6-96
STATMSR	Get statistics for a sequence window/collector with 1 sigma output.	6-96
STATMSR3	Get statistics for a sequence window/collector with 3-sigma output.	6-97
STATS	Statistics operation command; used to turn on/off, print, clear or ask for operator input	6-97
TEXT	Graphic display of text to screen	6-98
TIME	Places time system has been running into variable (in seconds*10).	6-98
TURRET	Position turret to location 1 through 5.	6-99
TURRETFF	Turns fastfocus on/off after each turret move.	6-99
TURRETPOS	Read current turret position.	6-99

Table 6-2. Alphabetical Summary List of Commands (Part 8 of 8)

Script Name	Function	Page Number
UPDATE	Update the realtime display.	6-99
XHAIR	Draw cross in center of screen	6-100
Z_MOVE	PIEZO move to Z axis position in nanometers	6-100
Z_REL	PIEZO move Z nanometers relative to current position	6-100

Listings by Function

This section lists script commands by functional category.

Comment and Debug Commands

These commands are used to comment and debug.

Table 6-3. Comment, Debug, and Ramfree Commands

Script Name	Functional Category	Page Number
COMMENT	Text to end of line Text comment; not executed	6-50
//:	Text to end of line Equivalent to COMMENT	6-50
COMMENT://	Vnum Strip comments to reduce file size.	6-50
//://	Vnum If (Vnum), strip comments while loading file.	6-50
DEBUG	Vstat Single-step script if (Vstat)	6-51
OPMARK	Marker used for debugging script	6-82
RP_DISPLAY	For DEBUG purposes; shows RP_WIN summed data.	6-92
SILENT	Toggles on and off if the interpreted commands will be echoed to screen	6-95

Measurement Setup Statistics and Execution Commands

These commands are used to load programs and to execute measurements.

Table 6-4. Measurement Setup Statistics and Execution Commands

Script Name	Functional Category	Page Number
LOADCALIB	Filename Load alternative calibration.	6-64
LOADSUBM	Load filename of multipoint calibration data file.	6-65
LOADCF	Filename Load calibration correction file.	6-65
LOADPROG	Vprogram_number Load program number.	6-65
MEASURE	Vpause Execute measurement.	6-76
MSR_DEFAULT	Vnumber Set value returned to RESULT if measurement error occurs.	6-80
MSR_ERROR	Gets flag for sequence Vseq. (0:none,1:+,2:-,3:?,4:user abort)	6-81
MSR_STATS	Set collector for gathering of standard measurement statistics (max=10).	6-81
RECALL	Vnumber Vx Vy Recall setup from program (0 - 10); optional Vx Vy will offset location of window from saved position.	6-89
RESULT	Vwindow Nresult Read measurement for window; window 0 for single measure.	6-91
MEASUREALGORIT-HM	Allows switching between standard measure/focus algorithm and average/min-max algorithm	6-76
PROGNUM	Get the number of the active program.	6-89
SITENAME	"name" Place text into measurement sitename.	6-95
STATMSR	Get statistics for a sequence window/collector with 1-sigma output.	6-96
STATMSR3	Get statistics for a sequence window/collector with 3-sigma output.	6-97
STATS	Satistics operation command. Used to turn on/off, print, clear or ask for operator input	6-97

SEQ Commands

The SEQ command functions are used to set up a measurement. An edge is defined within each of two windows for up to 10 separate measurements.

Table 6-5. SEQ Commands

Script Name	Functional Category	Page Number
SEQEDGE	Vseq Vvin Vaxis Vdir Vedge Vth TBS	6-93
SEQNAME	Vseq "text string" Set name of measure sequence Vseq.	6-94
SEQWIN	Vseq Vwin Vx0 Vy0 Vx1 Vy1 TBS	6-94
SEQOUTPUT	Select measurement output type, mean, maximum, minimum.	6-94

Image Function Commands

These commands are used to save an image into a file and to show the image on screen.

Table 6-6. Image Function Commands

Script Name	Functional Category	Page Number
PICSHOW	Vx Vy "pict" Show pict.bmp or .tif on screen at x, y; Vx and Vy equal -1, the operator can place the image on the screen.	6-83
PICTURE	Vx1 Vy1 Vx2 Vy2 "pict" Write picture from region as pict.bmp.	6-86
PICTURETIFF	Vx1 Vy1 Vx2 Vy2 "pict" Write picture from region as pict.tif.	6-86
PICTUREVGA	Vx1 Vy1 Vx2 Vy2 "pict" Write picture with VGA overlay as pict.bmp.	6-86

Screen Graphics Commands

These commands are used to manage screen graphics.

Table 6-7. Screen Graphics Commands

Script Name	Functional Category	Page Number
BOX	User-defined on-screen graphic Vx1 Vy1 Vx2 Vy2 Vcolor [Vfilled]	6-49
ERASE	Erase screen and redraw windows/realtime.	6-55
LINE	User-defined screen graphic to draw a line	6-64
TEXT	Graphic display of text to screen	6-98
UPDATE	Update the realtime display.	6-99
XHAIR	Draws cross in center of screen	6-100

Stage, Column, and Optical Positioning and Turret Command

This command allows the user to rotate the turret to a designated position (units = 0.5). The command is the programmed equivalent of the KMS 300 keypad turret increment and decrement keys. This function adjusts the stage, column, and Piezo coordinates. Turret offset values are stored in the system configuration file. These offsets reflect the differences in parfocality and parcentricity between the optical objectives installed in the turret.

Table 6-8. Stage, Column, and Optical Positioning Turret Commands

Script Name	Functional Category	Page Number
TURRET	Vposition Move turret to position 1-5.	6-98
TURRETFF	Turns fast focus on/off after each turret move	6-99
TURRETPOS	Read current turret position.	6-99

Illumination Values Commands

Gain and offset are video image amplification and contrast values; lamp is the brightness of the variable Halogen lamp, if present.

Table 6-9. Illumination Values Commands

Script Name	Functional Category	Page Number
GETWIN	Get screen position of measure window.	6-59
LUMAUTO	Adjusts system illumination to approximate LUMMARK values	6-67
LUMAVG	Averages the number of frames as setup in the program for image analysis	6-67
LUMDUMP	Dump illumination data of SEQWIN0 as comma-delimited data.	6-67
LUMMARK	Sets default values for illumination when used with LUMAUTO.	6-68
LUMREAD	Noffset Ngain Nlamp Set illumination values.	6-68
LUMSET	Voffset Vgain Vlamp Read illumination values.	6-68
METER	Place light intensity of RP_WIN into Vnum (1024 MAX).	6-77

Z-Axis Position Commands: Piezo Stack

These commands allow the user to control positioning of Z-axis using the Piezo stack/sensor array.

For stack size	=	(20 mm) 20000	nm	(30 mm) 30000	nm
Values range	=	{0...20000}	nm	{0...30000}	nm
Resolution	=	5	nm	8	nm
Typical error	=	10	nm	16	nm

Table 6-10. Z-Axis Position Commands: Piezo Stack/Sensor Array

Script Name	Functional Category	Page Number
GET_Z	NnumZ Get position z in NnumZ (0.001 mm units).	6-60
Z_MOVE	V_z Move to position z (0.001 mm units).	6-100
Z_REL	V_z Move relative distance z (0.001 mm units).	6-100

Z-Axis Position Commands: Column Motor

These commands allow the user to control positioning of Z-axis using the column motor.

Units	=	0.001 mm
Resolution	=	0.100 mm
Typical back-lash error	=	0.500 mm

Table 6-11. Z-Axis Position Commands: Column Motor

Script Name	Functional Category	Page Number
GETMOTCNTS	Get the motor position (not scales!) in um.	6-57
GET_MOT_Z	V_z Get motor z in NnumZ (0.001 mm units).	6-60
MOT_Z_MOVE	V_z Move to motor z (0.001 mm units).	6-77
MOT_Z_REL	V_z Move relative motor z (0.001 mm units).	6-78

X-, Y-Axis Position Commands: Stage Motors

These commands allow the user to control positioning of X-axis and Y-axis using the stage motors.

Units	=	1 um
Resolution	=	0.2 um
Typical error	=	1 um

Polar-Mask Coordinate Movement Commands

These commands allow the user to manage polar-mask coordinate movements.

Table 6-12. Polar-mask Coordinate Movement Commands (1 of 2)

Script Name	Functional Category	Page Number
ALIGN	Set current position as *align* point for subsequent DESKEW.	6-49
DESKEW	Set polar angle for coordinate system.	6-51
GETSTOP	Vstopnum V_x V_y [Valigned] Get stop in Vx, Vy in (aligned) coordinate system (in 1 microns).	6-58
GO_ORIGIN	Move stage to ORIGIN.	6-60
GOSTOP	Vstopnum Go to preprogrammed position 0 - 99.	6-60
MASK_ORIGIN	Set mask coordinate origin at current position or Vx Vy nms stage coordinates.	6-69
MOVEPOL	V_x V_y Move to position in aligned and deskewed coordinate system (in 1 microns).	6-78
MOVEPOLZ	V_x V_y Performs MOVEPOL: with Z-axis correction	6-79
MOVEPOL_NM	Move to 'polar' x/y @ 0.1 um resolution (in aligned + deskewed space).	6-79
MOVEPOLZ_NM	Move to 'polar' x/y coordinates with Z compensation in 0.1 um resolution.	6-80
ORIGIN	[V_x V_y] Set ORIGIN to current position (offset by optional V_x V_y values).	6-82
POSPOL	V_x V_y Get position in aligned and deskewed coordinate system (in 1 microns).	6-88

Table 6-12. Polar-mask Coordinate Movement Commands (2 of 2)

Script Name	Functional Category	Page Number
POSPOL_NM	V_x V_y Get 'polar' position in x/y coordinates @ 0.1 um resolution.	6-88
REL_POL	V_x V_y Move relative position in aligned and deskewed coordinate system (in 1 microns).	6-90
REL_POLZ	V_x V_y Performs REL_POL: with Z-axis correction for subject tilt. See PLANARIZATION commands.	6-91
REL_POL_NM	Move stage a relative x/y distance in 'polar' space with 0.1 um resolution.	6-91
REL_POLZ_NM	Stage relative in 'planar-polar' space (Z compensation) with 0.1 um resolution	6-91
SETSTOP	Vstopnum V_x V_y Set stop to V_x, V_y in coordinate system (in 1 microns).	6-95

Non-aligned Stage Movement Commands

These commands allow the user to manage non-aligned stage movement.

Table 6-13. Non-aligned Stage Movement Commands

Script Name	Functional Category	Page Number
GETPOS	NnumX NnumY Get position x in NnumX; y in NnumY.	6-57
GETPOS_NM	Get stg position in 0.1 um resolution.	6-57
POSMOVE	V_x V_y Move to position V_x, V_y.	6-87
POSMOVE_NM	Move stage to non-aligned x/y coordinates in 0.1 um resolution.	6-88
RELMOVE	V_x V_y Move relative position V_x V_y.	6-90
RELMOVE_NM	Move stage a relative x/y distance from current position in 0.1 um resolution.	6-90

Specialty Commands

These commands allow the user to manage edges.

Table 6-14. Specialty Commands

Script Name	Functional Category	Page Number
EDGES	Optional command to measure oblique features	6-53
EDGEPOS	Optional command to measure relative position of two edges	6-53
EDGEROUGHNESS	Optional command to measure edge roughness	6-54
STATEDGE	Measure edge statistics in subpixel values.	6-96

Planarization Commands

These commands define the slope of the stage and wafer. Three points define a plane, so the stage is positioned to three locations at far corners of the subject and PLANEPT is executed at each position. PLANECALC is then used to find the Z position of the subject surface at any X, Y location.

Table 6-15. Planarization Commands

Script Name	Functional Category	Page Number
MASK_PLANE	Vx_M1 Vy_M1 Vx_M2 Vy_M2 [Vx_M3 Vy_M3]; align/deskew and planecalc	6-70
PLANECALC	Adjust Z to bring surface into focus.	6-87
PLANEPT	{1| 2| 3} Set points to define surface plane.	6-87

Operator Interface Commands

These commands allow the operator to interface with the system.

Table 6-16. Operator Interface Commands (Part 1 of 2)

Script Name	Functional Category		Page Number
GETTEXT	"Text instruction"		6-58
	Get text from operator and output to log/printer.		
GETVAR	Nnum "description"		6-58
	Get value from operator; description is printed as message to operator.		
GRABSTAT	Vnum		6-61
	Turn video capture on/off.		
GSPAWN	Command parameters		6-61
	SPAWN in graphics mode (faster spawn)		
IDINFO	O/P/L/Tn "string"		6-63
	ID screen: Operator (O), Print (P), Logfile name (L) (sets logfile name to text string); Text (Tn) sets field 1 - 5 (n) to text string.		
LOCKOUT	Value		6-66
	If value is not 0, operator will not be able to stop script.		
LOGMEASURE	Vnum		6-66
	Log measurement on/off		
MAPMENU	N "filename"	Data Map Screen; name file	6-69
	C Vx Vy	Count x,y	
	D	Display screen	
MENU	Nnum, "title", item, item		6-76
	Offers operator list of buttons with labels itemized; returns button chosen in Nnum. Button texts are separated by commas. Optional title must be in quotes ("...").		

Table 6-16. Operator Interface Commands (Part 2 of 2)

Script Name	Functional Category	Page Number
MESSAGE	"Text string" Place text string on screen.	6-77
OPERATOR	"Text instruction" Give control to operator until ESC key is pressed.	6-81
PAUSE	Vseconds Pause for V seconds for inspection or other reason.	6-86
SPAWN	Command parameters Suspends KMS 300 operating system; executes a DOS command with parameters. Enter DOS, EXIT) to restore the KMS 300 operating system environment.	6-95
STATEDGE	Vedge [0,1] Vmax Vmin Vavg Vcnt Vstd_dev Get statistics from one of the last two edges in the measure sequence; all Vnums are required.	6-96

Data Output Matrix Commands

These commands allow the operator to read and write files as a two-dimensional matrix. Handles are used to refer to different matrices. For example, three matrices could be used to list parts, parts to be inspected, and part type at each site.

Table 6-17. Data Output Matrix Commands

Script Name	Functional Category	Page Number
MATRIXCLEAR	Clears all matrix files that are in the memory	6-72
MATRIXCLOSE	Nnumhandle Close MATRIX (frees memory)	6-72
MATRIXOPEN	Nnumhandle V_x V_y "file.ext" Open MATRIX and read x and y variables.	6-73
MATRIXSET	Nnumhandle V_x V_y Nnum Set MATRIX value X, y to value Vnum.	6-74
MATRIXVALUE	Nnumhandle V_x V_y Nnum Read MATRIX value x, y into Nnum.	6-74
MATRIXWRITE	Nnumhandle "file.ext" Write MATRIX file values as file.ext.	6-75

Log File Commands

These commands allow the operator to manage log files.

Table 6-18. Log File Commands

Script Name	Functional Category	Page Number
CLOCK	Used to record DOS clock [Vmth Vdy Vyr]/T[Vhr Vmn Vsc]; P=log DATE+TIME,D=DATE/T=TIME to Vnums	6-50
GETTEXT	Get a text string from the user and send to log file.	6-58
GSPAWN	Execute DOS command with parameter while in graphics mode.	6-61
IDINFO	Manipulate input to log file.	6-63
LOGMEASURE	Turns the measure logging on and off	6-66
PRINT	"Text string" Print text string to logfile/printer.	6-88
PRINTER	Logged data is echoed to printer.	6-88
PRINTSTR	Print "string" without CR/LF. (Follow command with PRINT: command.)	6-88
SEQNAME	Set the name of measure sequence.	6-94
SITENAME	Set the measure site name to 'name'.	6-95
SPAWN	Execute DOS command with parameters.	6-95
TIME	Places time system has been running into variable (in seconds*10).	6-98

Script Flow Commands

These script flow commands are used to set MARKERs. When using these commands, note that 'MARKERs' used are unique text strings.

Table 6-19. Script Flow Commands

Script Name	Functional Category	Page Number
CALL	Value MARKER If value not 0, call MARKER.	6-49
END	Nothing past END should be executed; eventually will not load past END.	6-55
EXIT	MARKER Set MARKER here for call, jump, loop. Set operator MARKER here (operator may jump script processing).	6-55
INCLUDE	Inserts a script segment from an existing file.	6-62
JUMP	Value MARKER If value not 0, jump to MARKER.	6-64
LOOP	Value MARKER If value not 0, loop back to MARKER.	6-66
MARK	MARKER Set MARKER here for CALL, JUMP, or LOOP.	6-71
MATH	Nnum = V1 op V2 Perform math on values or variables. Operation (op) may be +, -, *, /, <, >, or =.	6-71
QUIT	End script execution and restart.	6-89
RETURN	Return from subroutine.	6-92
START	Jump to start of script.	6-96

Edge Detection Pattern Recognition Commands

These commands allow the operator to locate edges within window similar to the way the measurement specification works (selecting an edge at a threshold level). Up to 10 recognition points may be specified, as well as the window within which to locate the points.

AXIS: HORZ = 0; VERT = 1
DIRECTION: NEG = 0; PLUS = 1
The upperleft corner of image is 0,0; the lower right is 639, 439.

Table 6-20. Edge Detection Pattern Recognition Commands

Script Name	Functional Category	Page Number
METER	N_lum Get average light intensity for RP_WIN.	6-77
RECPT	Vpt Vaxis Vdir Dedge Vth Set a point to search for.	6-90
RP_DISPLAY	Show intensity plots from RP_WIN.	6-92
RP_EXEC	Vstartpt Vpt_count Execute search, using Vstartpt to [Vstart + (Vpt_count)].	6-92
RP_READ	Vptnum N_location Get result from search for Vptnum.	6-92
RP_WIN	Vx1 Vy1 Vx2 Vy2 Set up window to search for points.	6-92

Bitmap/Image Pattern Recognition Commands

These commands allow the operator to locate edges within a window.

Table 6-21. Bitmap/Image Pattern Recognition Commands

Script Name	Functional Category	Page Number
PATREC_FIND	Find an image pattern matching model.	6-83
PATREC_GET	Retrieve results pattern match.	6-84
PATREC_SAVE	Save image of festure for PATREC_FIND command use.	6-85
PATREC_SHOW	Show a saved image.	6-85

Autofocus Commands

These commands use the current measurement setup to determine the edge on which to focus. Range is the first pass, which looks quickly for the peak focus; then the system uses the step to pass three times through the swing range looking for the best focus. The stage is positioned to the average best focus position of the three swings through focus. The focus quality is based on the derivative of the edge selected.

Table 6-22. Autofocus Commands

Script Name	Functional Category	Page Number
AF_EXEC	Perform autofocus.	6-48
AF_SET	Vrange Vswing Vstep Set up range, swing, and step.	6-48
AF_STAT	Vstat Turn focus on measure on/off.	6-48

Find Surface Command

This command works much like the AUTOFOCUS commands but uses the average image intensity to determine best focus.

Table 6-23. Find Surface Commands

Script Name	Functional Category	Page Number
FASTSURF	Find surface in confocal mode.	6-55
FINDSURF	Nzpos Return Piezo position at end of routine in variable Nzpos.	6-56

Fast Focus Commands

Fast focus routines are designed to find an image quickly (usually an autofocus is done prior to measurement). Intensity-based focus routines scan the range, searching for the peak intensity. Fast focus can also use the edge derivative for detecting focus instead of the peak image intensity.

Range and steps are in nanometers. When FOCUSFAST is invoked, the current Piezo position defines the mid-range point. The function is reliable when the focal plane is within one-half the specified range from the current Piezo position.

The focus will require time to complete (range/step * 1/15 second); a small step size and large range can result in a very slow focus.

Table 6-24. Fast Focus Commands

Script Name	Functional Category	Page Number
FF_SET	Vrange Vsetp Set range and step in nanometers. Use only if (Vsets) is not zero; otherwise, full Piezo range is used, and the default step is the range/150; for a 20 mm stack, 133 nm; for a 30 mm stack, 200 nm.	6-56
FF_WIN	Vx1 Vy1 Vx2 Vy2 Set up region to search for focus.	6-56
FOCUSFAST	Vtype Vsets Seek peak focus using Piezo. Minimum step is 5 nm if (Vtype) uses edge derivative and if (Vsets) uses FF_SET values.	6-57

Column Focus Command

The column focus function is useful in finding an image with low magnification objectives over an extended range, ordinarily more than 100 microns. Though column moves are motor-encoder based, the function returns a Z-scale position value. The entire video field is metered for peak intensity.

Caution: The column focus function can crash the optical objective into the specimen. The positive (lower) hardware Z-limit switch MUST be set before this function can be safely used. To set the Z-positive limit, proceed as follows:

1. Manually focus upon the highest feature of the specimen, using the highest (installed) magnification objective.
2. Note the Z-scale reading (in tenth microns).
3. Drive the objective 100 microns closer (up arrow key with FOCUS ICON selected) to the specimen.
4. Using an 1/8-inch Allen key, set the Z-limit so that the limit LED illuminated at this point.

Table 6-25. Column Focus Command

Script Name	Functional Category	Page Number
FOCUSIMG	Vsets Vtype Seek peak focus using column (minimum step is 100 nm). If Vsets, uses FF_SET values; if Vtype, uses edge contract; otherwise uses peak intensity (confocal).	6-57

Script Commands

This section provides detailed information for all script commands. Script commands are listed in alphabetical order.

AF_EXEC

FUNCTION	Executes autofocus. Uses the current SEQWIN to autofocus, utilizing the current settings in AF_SET: for Range Swing and Step
USE	Searches through RANGE nanometers (within Piezo range) for the best focus. After it passes through the best focus, it SWINGS back through the focus, STEP nanometers at a time until it finds the BEST focus.
OPTIONS	None. Execution of the command takes no parameters.
EXAMPLE SCRIPT	AF_SET: 1024 256 16 AF_EXEC:
RELATED PROCEDURES	AF_SET; SEQWIN; AFSTAT

AF_SET

FUNCTION	Vrange Vswing Vstep Sets the Range Swing and Step for the AF_EXEC command.
USE	Sets the Range, Swing and Step parameters for autofocus in Piezo ticks. For the 20 micron Piezo, each tick is 4 nm; for the 30 micron Piezo, each tick is 7 nanometers. This is the resolution of focus for the respective Piezo’s.
OPTIONS	None
EXAMPLE SCRIPT	AF_SET: 1024 256 16AF_EXEC:
RELATED SCRIPTS	AF_SET; AFSTAT

AF_STAT

FUNCTION	Toggle Autofocus on measurement. AF_STAT:[0|1]
USE	Allows script control of measurement autofocus. Usually set to on by default, and best left on for the most reliable and repeatable measurements.
OPTIONS	None
EXAMPLE SCRIPT	AF_STAT:0
RELATED SCRIPTS	AF_SET; AF_EXEC

ALIGN

FUNCTION	ALIGN
USE	Allows using a set of features other than the ORIGIN: feature for setting the angle offset between the mask coordinates and the stage coordinates.
OPTIONS	None.
EXAMPLE SCRIPT	ALIGN:
RELATED SCRIPTS	ORIGIN; DESKEW; MASK_PLANE

BOX

FUNCTION	BOX: Vx1 Vy1 Vx2 Vy2 Vcolor [Vfilled]
USE	Draws a box on the screen with Vx1 Vy1 as the top left and Vx2 Vy2 as the bottom right corner, color Vcolor, and optionally filled or not.
OPTIONS	If Vfilled is 1, then the box will be a solid color.
EXAMPLE SCRIPT	BOX:100 100 200 250 8 0
RELATED SCRIPTS	LINE; XHAIR; ERASE

CALL

FUNCTION	CALL: Vnum MARKER; if Vnum is non-zero, call subroutine MARKER
USE	Calls the subroutine MARKER if Vnum is nonzero. Can be used in conjunction with the MATH: command to perform conditional execution of subroutines
OPTIONS	N/A
EXAMPLE SCRIPT	CALL:V67 SITESCAN
RELATED SCRIPTS	MARK; LOOP; JUMP; MARK; MENU

CLEARPIC

FUNCTION	CLEARPIC: erase the displayed picture
USE	Removes the picture displayed on the screen; mostly used by TIC internally for debugging purposes
OPTIONS	N/A
EXAMPLE SCRIPT	CLEARPIC:
RELATED SCRIPTS	PICSHOW

CLOCK

FUNCTION	CLOCK: P/D[Vmth Vdy Vyr]/T[Vhr Vmn Vsc]; P=log DATE+TIME, D=DATE/T=TIME to Vnums
USE	Allows time and date information to be manipulated under script control, as well as logging it to the logfile
OPTIONS	P - print to logfile D- copy date information to variables (mo/day/year) T- copy time information to variables (hr:min:sec)
EXAMPLE SCRIPT	CLOCK: T V20 V21 V22
RELATED SCRIPTS	PRINT:

COMMENT

FUNCTION	COMMENT: [//num]; comments (if num==1,NOT) loaded - text to end of line	
USE	Signals a COMMENT line in the script. If the first line in the script and //num not 0, then all comments will be stripped	
OPTIONS	P - print to logfile D- copy date information to variables (mo/day/year) T- copy time information to variables (Hr:min:sec)	
EXAMPLE SCRIPT	COMMENT: Script Title or //: Script Title or //://:1	All comment lines will be eliminated from system memory

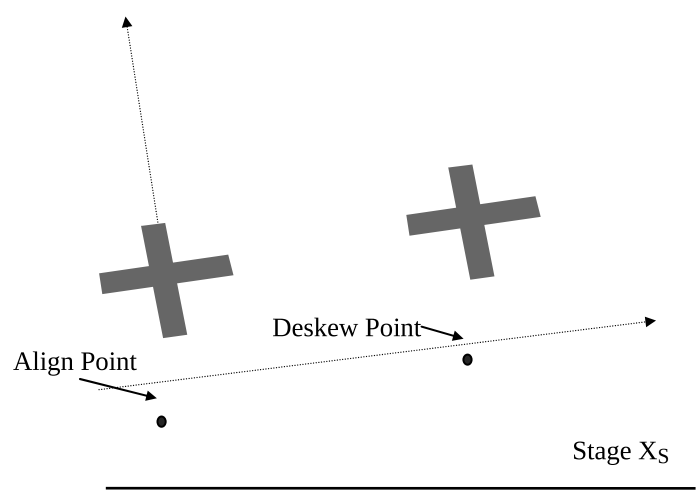
DEBUG

FUNCTION	DEBUG: Vnum;[0|1] 0 - turns off script single stepping 1 - turns on script single stepping
USE	Toggles the single step mode for scripting: useful to follow execution of script commands closely
EXAMPLE SCRIPT	DEBUG:1
RELATED SCRIPTS	SILENT:

DESKEW

FUNCTION	DESKEW - Calculate the 'skew' angle for the mask vs. stage
USE	The DESKEW point is the second of two alignment points defining the misplacement of the mask (and/or mask holder) on the stage (Figure 6-1).
EXAMPLE SCRIPT	ORIGIN: RELMOVE:130000 0 XHAIR: MENU: V99 ALIGN TO XHAIR DESKEW:
RELATED SCRIPTS	ALIGN, ORIGIN, MASK_ORIGIN

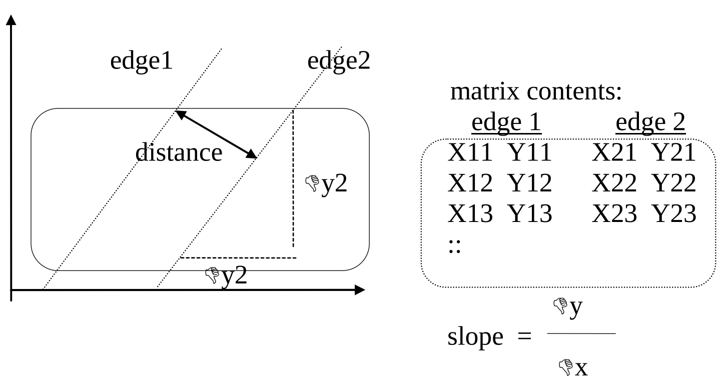
Figure 6-1. Deskew Pint



EDGES

FUNCTION	EDGES: Vhndl Vlines [Vslope1 Vslope2 Vdistance] Store x,y positions into matrix with optional slope of edges Vhandl is variable to be used for the matrix handle (20 max handles). Vlines is the variable where the number of scan lines is returned. $Vslope_1$ is the variable where the slope x 1000 of edge 1 is returned. $Vslope_2$ is the variable where the slope x 1000 of edge 2 is returned. Vdistance is the variable where the perpendicular distance (nanometers) will be returned.
USE	Opens a MATRIX to Vhndl then executes the script command 'MEASURE: 1'; storing the x,y screen coordinates of the two edges into a matrix whose handle is Vhndl. The matrix *y-dimension* is returned in variable Vlines where the x-*dimension* of the matrix is fixed at 4.
OPTIONS	Vslope1 = slope1 * 1000 of edge 1 Vslope2 = slope2 * 1000 of edge 2 Vdistance = perpendicular distance between the two edges at the initial positions
EXAMPLE SCRIPT	SEQWIN:1 0 V20 V16 V21 V17 SEQWIN:1 1 V20 V16 V21 V17 SEQEDGE:1 0 0 0 1 35 SEQEDGE:1 1 0 0 2 35 EDGES: V50 V55 V51 V52 V53 MATRIXWRITE: V50 EDGESXY.MTX MATRIXCLOSE: V50
RELATED SCRIPTS	MATRIXWRITE, MATRIXVALUE (Figure 6-2)

Figure 6-2. Matrix Edges



EDGEPOS

FUNCTION

EDGEPOS: Vhndl Vedge1 Vedge2 Vcenter
Store x,y edge coordinates into matrix with and return mean edge position and center.

Vhandl is variable to be used for the matrix handle (20 max handles opened).
Vedge1is variable to be used for returning the position of edge1 in nm.
Vedge2 is variable to be used for returning the position of edge2 in nm.
Vcenter is variable to be used for returning the position of the center.

USE

Opens a MATRIX then executes 'MEASURE: 1'; storing the x,y screen coordinates of the two edges into a matrix whose handle is Vhndl. The matrix *y-dimension* is returned in variable Vlines where the *y-dimension* is fixed at 4.

This command assumes horizontal or vertical edges and parallel. The edge coordinate returned is the mean of x's (or y's if edge direction is horizontal).
Vcenter = (Vedge1 + Vedge2)/2.

The purpose of this command is to determine the accuracy of the overlaying of one layer upon another by locating the central demarcation.

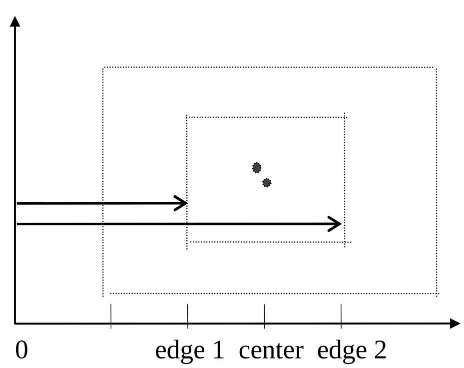
EXAMPLE SCRIPT

Figure 6-3 is an example of the Matrix Edge Position.
SEQWIN:1 0 V20 V16 V21 V17
SEQWIN:1 1 V20 V16 V21 V17
SEQEDGE:1 0 0 0 1 35
SEQEDGE:1 1 0 0 2 35
EDGEPOS: V50 V47 V48 V49
::
::
MATRIXCLOSE: V50

RELATED SCRIPTS

MATRIXWRITE, MATRIXVALUE, EDGES (Figure 6-3)

Figure 6-3. Matrix Edge Position

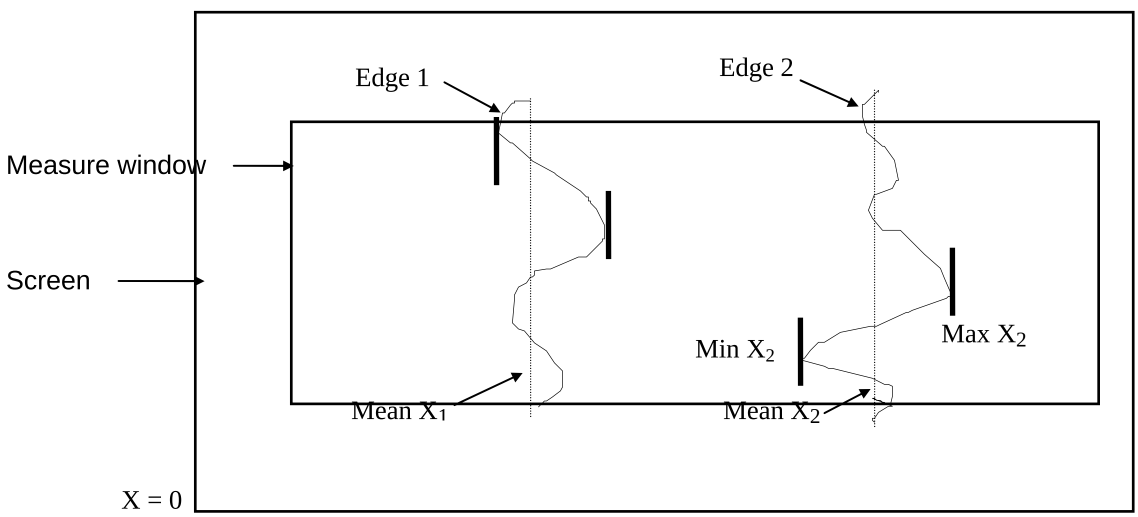


EDGEROUGHNESS (EDGER)

FUNCTION	EDGEROUGHNESS - statistics on two edges EDGEROUGHNESS: Vhndl V1min V1max V1stddev V2min V2max V2stddev Vhndl variable for the matrix handle (20 max matrices opened at once) V1min variable for minimum X/Y nanometers, edge 1 V1max variable for maximum X/Y nanometers, edge 1 V1stddev variable for standard deviation nm x 1000, edge 1 V2min variable for minimum X/Y nanometers, edge 2 V2max variable for maximum X/Y nanometers, edge 2 V2stddev variable for standard deviation nm x 1000, edge 2
USE	Opens a matrix of N lines by 4 columns to matrix handle *Vhndl*. Minimum and maximum positions, standard deviation of edges is returned. Positional data is nanometers from edge of screen. Standard deviation is calculated using the equation.
EXAMPLE SCRIPT	EDGEROUGHNESS: V11 V12 V13 V14 V15 V16 V17 MESSAGE: “Min X1 = % (nm), Max X1 = % (nm)”, V12, V13 MATRIXWRITE: V11 EDGESXY.MTX MATRIXCLOSE: V11
RELATED SCRIPTS	STATEDGE

Figure 6-4. Example on Vertical Edges - Edge Roughness

$$\sqrt{\frac{N\sum(X^2) - (\sum X)^2}{N(N-1)}}$$



END

FUNCTION	END:
USE	End script execution and reset to start of script.
EXAMPLE SCRIPT	END:
RELATED SCRIPTS	QUIT; EXIT

ERASE

FUNCTION	ERASE:
USE	Clears any drawn graphics on the screen and redraws the SEQWIN’s
EXAMPLE SCRIPT	ERASE:
RELATED SCRIPTS	BOX; LINE; XHAIR; UPDATE

EXIT

FUNCTION	EXIT:
USE	End script execution and reset to start of script.
EXAMPLE SCRIPT	EXIT:
RELATED SCRIPTS	QUIT; END

FASTSURF

FUNCTION	FASTSURF: [Vnano]; Refine surface +/-(Vnano/2) ->use FF_WIN.(Vnano dflt = 3000) Vnano - range to search (in nm) Uses FF_WIN
USE	Resolves surface (best) in range of Vnano nanometers. Machine MUST be in confocal mode.
EXAMPLE SCRIPT	FASTSURF:10000
RELATED SCRIPTS	FOCUSFAST; FINDSURF; FOCUSIMG

FF_SET

FUNCTION	FF_SET: Vrange Vstep; units are in nm Vrange - range to focus through (nm) Vstep - stepsize (nm)
USE	Sets range and step for the FOCUS commands FOCUSFAST and FOCUSIMG will search through the range selected to find the best focus (either surface or edge) within the range.
EXAMPLE SCRIPT	FF_WIN:120 140 520 340 FF_SET:10000 500 FOCUSFAST:1 1
RELATED SCRIPTS	FOCUSFAST; FINDSURF; FOCUSIMG; FF_WIN

FF_WIN

FUNCTION	FF_WIN: Vx1 Vy1 Vx2 Vy2
USE	Sets the region of interest for focus commands. The focus commands will use this window, in conjunction with the FF_SET parameters to find the best focus.
EXAMPLE SCRIPT	FF_WIN:100 100 540 450
RELATED SCRIPTS	FOCUSFAST; FOCUSIMG

FINDSURF

FUNCTION	FINDSURF: [Vnum]; If Vnum return Piezo stack position in Vnum Uses RP_WIN as region of interest.
USE	Finds best surface in RP_WIN and optionally returns the Piezo stack position in Vnum. Used to quickly find the best “surface”. Must be in Confocal mode.
EXAMPLE SCRIPT	RP_WIN:100 100 200 200 FINDSURF:V97
RELATED SCRIPTS	FOCUSFAST; FASTSURF; FOCUSIMG; RE_WIN

FOCUSFAST

FUNCTION	Fast Piezo focus FOCUSFAST: [Vtype 0|1] [Vwin] Vtype 0 for confocal mode focus 1 for 'best edge' focus Vwin 1 to use the FF_WIN window
USE	One pass through the *range* every *step* nanometers, to determine best focus position
EXAMPLE SCRIPT	FF_WIN:120 140 520 340 FF_SET:10000 500 FOCUSFAST:1 1
RELATED SCRIPTS	FOCUSIMG; AF_EXEC; FF_SET; FF_WIN

FOCUSIMG

FUNCTION	Focus using column FOCUSIMG: [flg1[flg2]]; If flg1 use FF_SET and FF_WIN as in FOCUSFAST If flg2 = 0 find surf, else find edge
USE	One pass through the *range* every *step* nanometers, to determine the best focus position
EXAMPLE SCRIPT	FOCUSIMG:1 0
RELATED SCRIPTS	FOCUSFAST; FINDSURF; FOCUSIMG; FF_SET; FF_WIN

GETMOTCNTS

FUNCTION	GETMOTCNTS: Vx [Vy [Vz]] Reads motor positions in um
USE	Allows the script to directly read the motor position in counts
EXAMPLE SCRIPT	GETMOTCNTS:V1 V2 V3
RELATED SCRIPTS	GETPOS; GETMOTZ; GET_Z

GETPOS

FUNCTION	GETPOS: VnumX VnumY Puts stage position (from scales) in VnumX and VnumY
USE	Allows script reading of stage position in absolute scale coordinates
OPTION:	GETPOS_NM:VnumX VnumY output in 0.1 um resolution
EXAMPLE SCRIPT	GETPOS:V12 V13
RELATED SCRIPTS	GETMOTCNTS; GETPOS; GET_MOT_Z; GET_Z; POSPOL

GETSTOP

FUNCTION	Vstopnum Vx Vy [Valigned] get (aligned) coordinates of STAGE STOP
EXAMPLE SCRIPT	GETSTOP: 20 V10 V11
RELATED SCRIPTS	GOSTOP; SETSTOP

GETTEXT

FUNCTION	GETTEXT: “prompt” [“default text”] Get a text string from the user and output it to the log file
USE	Allows a means for the user to annotate the log file while a script is running.
EXAMPLE SCRIPT	GETTEXT:"Input Wafer ID"
RELATED SCRIPTS	GETVAR: PRINT: PRINTSTR:

GETVAR

FUNCTION	GETVAR: Obtain numerical value from operator GETVAR: Vnum “Prompt message”
USE	A prompt and an entry window is displayed for the operator to enter a value. The entered value is placed into the script variable Vnum.
EXAMPLE SCRIPT	Figure 6-5 is an example of how the operator can specify the numerical portion of a file.
RELATED SCRIPTS	GETTEXT; PRINT; PRINTSTR: String Substitutions

Figure 6-5. Example of Specifying Numerical Portion

GETVAR: V01 “Enter 1 through 4 digits for MATxxxx.MTX file”

Enter 1 thru 4 digits for MATxxxx.MTX file

100

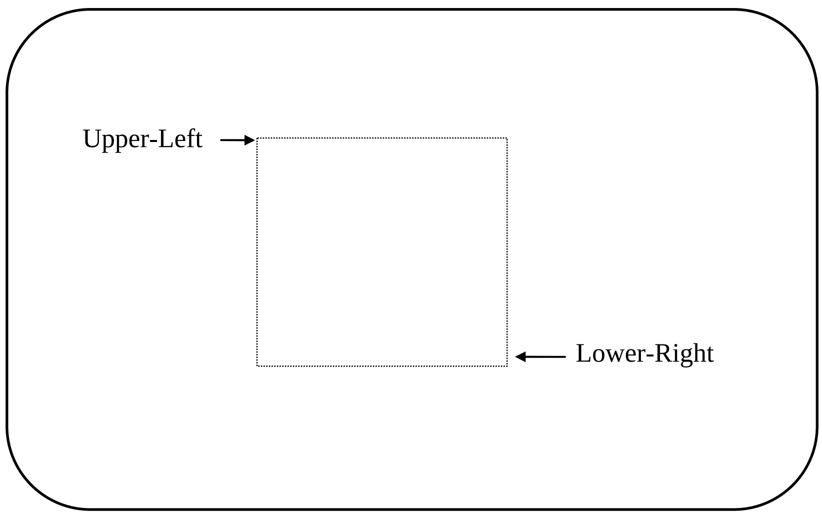
MAT100.MTX

MATRIXOPEN: V02 5 10 “MAT**%**.MTX”, V01
::
::
MATRIXWRITE: V02 “MAT%.mtx”, V01
MATRIXCLOSE: V02

GETWIN

FUNCTION	GETWIN - Obtain display screen coordinates of a measurement window. GETWIN: WIN# Vx1 Vy1 Vx2 Vy2
USE	For measurement window *WIN#* = 0 or 1, place the window coordinates of the upperleft and lowerright corners into the script variables Vx1, Vy1, Vx2, Vy2. The coordinates match the output from the manual operation *CTRL-W*.
EXAMPLE SCRIPT	Figure 6-6 is an example of display screen coordinates of measurement windows GETWIN: 0 V21 V22 V23 V24 PRINT: “Coordinates of Window 0, Upper-Left = % %”, V21, V22 PRINT: “Coordinates of Window 0, Lower-Right = % %”, V23, V24

Figure 6-6. Display Screen Coordinates of Measurement Windows



GET_MOT_Z

FUNCTION	GET_MOT_Z: VnumZ (units are .001 um) Gets column position in nm and stores it in the variable VnumZ
USE	Allows the script to be able to read the column position. Mostly useful for setting the Piezo stack to certain position for consistent Z-depth measurement readings.
EXAMPLE SCRIPT	GET_MOT_Z:V29 GET_Z:V30 MATH:V31=9500-V30 MOT_Z_REL
RELATED SCRIPTS	GET_MOT_Z; MOT_Z_MOVE; MOT_Z_REL; Z_MOVE; Z_REL

GET_Z

FUNCTION	GET_Z:VnumZ (units are .001 um) Gets Piezo position in nm and stores it in the variable VnumZ
USE	Allows the script to be able to read the Piezo stack position. Mostly useful for setting the Piezo stack to certain position for consistent Z-depth measurement readings.
EXAMPLE SCRIPT	GET_MOT_Z:V29 GET_Z:V30 MATH:V31=9500-V30 MOT_Z_REL
RELATED SCRIPTS	GET_MOT_Z; MOT_Z_MOVE; MOT_Z_REL; Z_MOVE; Z_REL

GO_ORIGIN

FUNCTION	GO_ORIGIN: Moves the stage to the ‘polar aligned’ origin
USE	A simple method of moving to the origin of the stage set via the origin command
EXAMPLE SCRIPT	GO_ORIGIN:
RELATED SCRIPTS	ORIGIN: DESKEW: MOVEPOL: MOVEPOLZ:

GOSTOP

FUNCTION

GOSTOP: VStopNum
Go to pre-programmed STAGE STOP VstopNum.

USE

Allows the script to be able to move the stage to preset positions setup in manual mode. See user’s guide for information pertaining to setting up and using stage stops (Appendix A).

EXAMPLE SCRIPT

```
MATH:V11=1
MARK:MOVE_NEXT_SITE
GOSTOP:V11
PAUSE:2
MATH:V11=V11+1
MATH:V12=V11<10
LOOP:V11 MOVE_NEXT_SITE
```

(Loops through the first 10 gostops).

RELATED SCRIPTS

MOVEPOL; MOVEPOLZ; RELMOVE;REL_POL; REL_POLZ

GRABSTAT

FUNCTION

GRABSTAT: Vnum [0|1]
Toggles the acquisition of video images; useful mainly for debugging the system

USE

Allows the frame grabber to be toggled off so that a static image can be overlaid on the VGA display; mostly used by TIC internally for debugging purposes

EXAMPLE SCRIPT

GRABSTAT:0

RELATED SCRIPTS

PICSHOW; PICTURE; PICTURETIFF; PICTUREVGA

GSPAWN

FUNCTION

GSPAWN: command [parameters]
Performs a DOS command without leaving the current video mode; a faster spawn command.

USE

Allows the script to execute DOS commands (run batch files, copy and delete files, etc.) while under script control; useful for automating data transfer with the KMS

EXAMPLE SCRIPT

GSPAWN: "delete logfile.log"

RELATED SCRIPTS

SPAWN:

INCLUDE

FUNCTION

INCLUDE - merge script code from other SCRIPT files.
INCLUDE: “filename”

USE

The script code from “filename” will be inserted at the location where the INCLUDE script command is located.

LIMITATIONS

The total size of the script with *includes* cannot exceed 65,000 bytes.

Nested INCLUDEs are not supported (for example, you cannot use INCLUDE command in the included “filename”).

EXAMPLE SCRIPT

```
MATH: V11=V11-1
INCLUDE: “script1.scr”
CALL:1 GLOBAL

  JUMP:1 FINI
INCLUDE: “script2.scr”
MARK: FINI
  TURRET:1
EXIT:
```

file script1.scr

```
MATH:V099=V013
MATH:V98=0-V011
MOVEPOLZ:V099 V98
```

file script2.scr

```
MARK:GLOBAL
  FF_SET:30000 2000
  FF_WINDOW:150 100 500 400
RETURN:
```

is equivalent to:

```
  MATH: V11=V11-1
  MATH:V099=V013
  MATH:V98=0-V011
  MOVEPOLZ:V099 V98
  CALL:1 GLOBAL


  JUMP:1 FINI
MARK:GLOBAL
  FF_SET:30000 2000
  FF_WINDOW:150 100 500 400
RETURN:
MARK: FINI
  TURRET:1
EXIT:
```

RELATED SCRIPTS

CALL:

IDINFO

FUNCTION	IDINFO set and print ID information and filename for a log file IDINFO: T[1-5][“string”] | L “string” | O | P
USE	IDINFO: O Operator display of default ID information. Operator may modify any of the fields: use up/down arrows to highlight field - Select - modify the entry - Escape.

IDINFO: P ‘Prints’ the ID info into the logfile in the following format:

```
- ID SCREEN INFO -
OPERATOR      : TECHNICAL INSTRUM
SUBSTRATE     :
PROCESS       :
PRODUCTION #:
DEVICE        :
------------------------
```

IDINFO:	T1 TECHNICAL INSTRUM	sets OPERATOR field
IDINFO:	T2 CHROME ON GLASS	sets SUBSTRATE field
IDINFO:	T3 SCRIPT TESTING	sets PROCESS field
IDINFO:	T4 05SEPT1995	sets PRODUCTION field
IDINFO:	T5 KMS300	sets DEVICE field
IDINFO:	L run102.log	sets LOGFILE field

NOTES on LOGFILE NAME:

- Filename.ext is maximum of 12 characters, 8 filename + 1. + 3 ext
- If filename portion only is specifed, the KMS program number is appended (e.g., run102.044 if run102 is specified)
- If filename portion and the ‘.’ is specified, no extension will be appended
- If no filename is specifed, the date will be used (eg ‘LFmmddyy.###’)

EXAMPLE SCRIPT

IDINFO: O allows operator to set ID information and filename
IDINFO: P print ID information to logfile
::
::
PRINT: “PITCH = %”, V03 prints value in V03 to logfile (assumes no printer)

RELATED SCRIPTS PRINT, PRINTSTR

JUMP

FUNCTION	JUMP: Value MARKER If Value then jump FORWARD to MARKER in script
USE	Allows conditional branching and execution in the script; used with MATH: commands to control the flow of the script.
EXAMPLE SCRIPT	MATH:V66=8 MATH:V67=V66<10 JUMP:V67 MAKE_IT_HAPPEN
RELATED SCRIPTS	MATH: LOOP: MARK: CALL

LINE

FUNCTION	LINE: Vx1 Vy1 Vx2 Vy2 Vcolor Draws a line of Vcolor (system color number) from Vx1 Vy1 to Vx2 Vy2 on the screen
USE	Draws a line between the two defined points on the screen; useful in debugging scripts to visualize which edges were found with the pattern recognition commands
EXAMPLE SCRIPT	LINE:100 100 100 300 8
RELATED SCRIPTS	BOX: XHAIR: ERASE:

LOADCALIB

FUNCTION	LOADCALIB: "filename"; load calibration file Allows the script to read a different calibration file; allows several programs to “share” a common calibration
USE	Useful to ensure that the script has the proper calibration, or to allow a script to change calibration if, say a 50 x measurement is desired. Allows several programs (and their associated stagestops) to share the same calibration
EXAMPLE SCRIPT	LOADCALIB: "CALIBRAT.005"
RELATED SCRIPTS	LOADCF: LOADPROG: LOADSUBM

LOADCF

FUNCTION	LOADCF:"Filename" Loads a .CRF file generated by CFCALC
USE	Allows a script to call in a multi-point calibration correction file that accounts for any non-linearity of the optics/measurement (i.e., the sub micron range).
EXAMPLE SCRIPT	LOADCF:"x-corr.crf"
RELATED SCRIPTS	LOADCALIB: LOADPROG: LOADSUBM

LOADPROG

FUNCTION	LOADPROG:Vnum; Loads program Vnum and all associated files into the system.
USE	Allows a script to call in a different program. Useful to ensure that the script is running with the proper program.
EXAMPLE SCRIPT	LOADPROG: 004
RELATED SCRIPTS	LOADCALIB: LOADCF: LOADSUBM

LOADSUBM

FUNCTION	LOADSUBM - load multi-point calibration data file LOADSUBM: “file.ext” “file.ext” Filename of multi-point calibration data file The following error message is displayed if the SUBM (multi-point calibration) is not enabled: SUBM COMMAND IS INVALID
USE	Load a new multi-point calibration data file. This calibration data file does not change a program’s default calibration data file. To change the default data file, the calibration data file must still be entered with Program Setup and Program Save in the main menu.
OPTIONS	
EXAMPLE SCRIPT	MATH: V1200=1 LOADSUBM “MULTIPT\HORZCLR.DAT” *load the calibration file* MEASURE: V1200 ::: ::: EXIT:
RELATED SCRIPTS	LOADPROG; LOADCALIB; LOADCF

LOCKOUT

FUNCTION	LOCKOUT: Value ; [0|1] Locks an operator out of ESCaping script processing
USE	Allows the script author to control access to breaking out of script processing; useful to ensure measurement integrity
EXAMPLE SCRIPT	LOCKOUT: 1

LOGMEASURE

FUNCTION	LOGMEASURE: Value Value toggles the logging of measurement data to the logfile. 0-disabled, 1-enabled
USE	Allows script control of the log data to log file (i.e., PRINTER command under measure menu in manual mode).
EXAMPLE SCRIPT	LOGMEASURE:0
RELATED SCRIPTS	PRINT; PRINTSTR; RESULT

LOOP

FUNCTION	LOOP: Value MARKER if (Value ≠ 0) loop back to MARKER
USE	Allows flow of control within script processing to change.; useful as a looping structure
EXAMPLE SCRIPT	MATH: V00 = 100 MARK: TOP_OF_LOOP MATH: V99 = V99 - 1 MESSAGE: "Loop Countdown = %", V99 LOOP: V99 TOP_OF_LOOP
RELATED SCRIPTS	JUMP: CALL:

LUMAUTO

FUNCTION	Adjusts system illumination to approximate LUMMARK contrast values
EXAMPLE SCRIPTS	LUMMARK: LUMAUTO: MEASURE:
RELATED SCRIPTS	LUMMARK; LUMSET; LUMREAD

LUMAVG

FUNCTION	LUMAVG: Viterations ”Filename” Viterations
USE	Averages the number of frames as set up in the program. Performs this averaging of frames for the number of iterations specified. An average of all the averages is computed. The final average illumination values in the measure window area are then written into the filename as a comma-separated value file which can then be imported into a spreadsheet for graphing or other data analysis.
EXAMPLE SCRIPT	MATH: V10=2 LUMAVG: V10 ”AVERAGE.IMG”
RELATED SCRIPTS	LUMDUMP; SEQWIN

LUMDUMP

FUNCTION	LUMDUMP:"Filename"
USE	Writes the illumination values in SEQWIN 0 (0-255) into filename as a comma-separated value file, which can then be imported into a spreadsheet for graphing or other data analysis
EXAMPLE SCRIPT	LUMDUMP:"Window0.csv"
RELATED SCRIPTS	METER, SEQWIN, LUMAVG

LUMMARK

FUNCTION	Sets default values for illumination contrast when used with LUMATUO
EXAMPLE SCRIPTS	LUMSET: L30 G32 O52 C20 S8 LUMMARK: or MESSAGE: "SET ILLUMINATION" OPERATOR: LUMMARE:
RELATED SCRIPTS	LUMSET; LUMREAD; LUMAUTO

LUMREAD

FUNCTION	LUMREAD: [OVoffset] [GVgain] [LVlamp] [AVanalog gain] [CVcamera gain] [SVshutter speed]
USE	Reads the current illumination values into the respective variables. Useful to allow a script to auto meter the illumination values. For the KMS 400 systems, camera gain and shutter speed can be read into variables also.
EXAMPLE SCRIPT	LUMREAD:OV44 GV45 CV46
RELATED SCRIPTS	LUMSET; METER; LUMMARK: LUMAUTO

LUMSET

FUNCTION	LUMSET: [Onoffset] [Gngain] [Lnlamp] [Ananalog gain] [Cncamera gain] [Snshutter speed]
USE	Sets the illumination gain and offset to the respective values. Sets lamp percentage to the value. Used in conjunction with the meter command for auto-metering routines. For KMS 400 systems, the camera gain and shutter speed can be set.
EXAMPLE SCRIPT	LUMSET: Gvnum OVNum LVnum
RELATED SCRIPTS	METER; LUMREAD; LUMMARK; LUMAUTO

MAPMENU

FUNCTION — DataMap screen
MAPMENU: [N "data file"]|[C Vdimx Vdimy]|[S Vscale]|[D]|[PD PS PV]

USE

OPTIONS
N "datafile"   Name of *matrix* file (.mtx) to read
C Vdimx Vdimy   Number of rows and columns in matrix, maximum 1500 each
S Vscale   Scale for DataMap
PD   Print display - matrix values
PS   Print statistics
PV   Print video

EXAMPLE SCRIPT
MATRIXCLOSE: V200 "DATA.CSV"
MAPMENU:N"DATACSV

MASK_ORIGIN

FUNCTION — Set mask coordinates origin
MASK_ORIGIN: [VX_s VY_s]

VX_s VY_s Stage coordinates, nanometers, at which mask 0,0 should be set

USE — Establishes the position at which the mask x-y coordinates are 0,0.

OPTIONS — ORIGIN

EXAMPLE SCRIPT — MASK_ORIGIN: 65000300 65000150

RELATED SCRIPTS — ORIGIN

MASK_PLANE

FUNCTION

MASK_PLANE - Planarize the mask

MASK_PLANE: X_{m1} Y_{m1} : X_{m2} Y_{m2}: X_{m3} Y_{m3}

USE

Given mask positions and an assumed [approximate] mask origin, the system moves to each x-y point in turn. At each point the operator should bring the feature into focus and refine the positioning. Figure 6-7 is an example of the mask plane. The system determines:

Z TILT allow focusing when moving in x-y
MASK X-Y 'deskew' angle

OPTIONS

Two points may be used with sacrifices in accuracy.

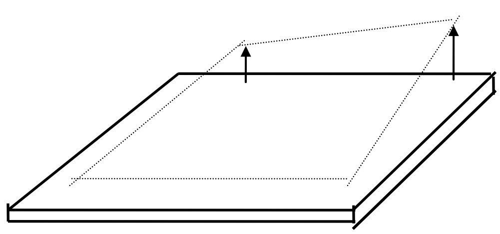
EXAMPLE SCRIPT

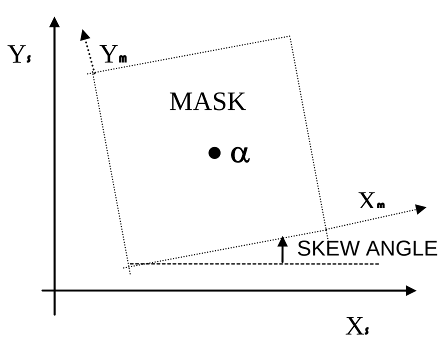
//: The following example opens a 'matrix' file defining the x-y positions of
//: three fiducials for a mask templates (Mask coordinates)
MATRIXOPEN: V10 6 4 "FIDUCIAL.MAR"
MATRIXVALUE: V10 1 2 V21
MATRIXVALUE: V10 2 2 V22
MATRIXVALUE: V10 3 2 V23
MATRIXVALUE: V10 4 2 V24
MATRIXVALUE: V10 5 2 V25
MATRIXVALUE: V10 6 2 V26
//:
//: Planarize for all moves in x-y-z
MASK_PLANE: V21 V22 V23 V24 V25 V26
//:
//: Move to a position adjusting for inexact plate placement (deskew)
//: nonplanar surface & nonplanar up/down movements
GOSTOP: 99

RELATED SCRIPTS

ORIGIN, ALIGN, DESKEW, PLANEPT, PLANECALC, MASK_ORIGIN

Figure 6-7. Example of Mask Plane





MARK

FUNCTION MARK: Marker

USE Sets a label that signifies the beginning of a subroutine that can be called with a JUMP:, LOOP: or CALL: command.

EXAMPLE SCRIPT MARK:POLE_LOACATION

RELATED SCRIPTS CALL; JUMP; LOOP;OPMARK

MATH

FUNCTION MATH: Vxx=VxyOpVyy
Where Op is +.-,/,=,SIN, COS SQRT
The Op value can be any one of the symbols shown in Table 6-26:

Table 6-26. Op Values

Symbol	Meaning
+	Plus
-	Minus
*	Multiply
=	Equals
/	Divide
!	Not
|	Or
<	less than
>	greater than
SIN	Sine
COS	Cosine
SQRT	Squareroot
&	And

USE Allows script processing of various mathematical operations; most often used to set conditions for the branching commands

EXAMPLE SCRIPT MATH:V27=V26<10

RELATED SCRIPTS METER, SEQWIN

MATRIXCLEAR

FUNCTION	MATRIXCLEAR Free memory for all matrices opened by the MATRIXOPEN command
USE	Provides ability to free memory allocated to all opened matrices. This command should be used with caution. When this command is executed, memory is freed and all matrix handles become invalid. The matrices do not get written to their respective files. Also, the matrix files must be re-opened in order to regain access to the data in the files. It is advised that this instruction be used only if the logic in the script becomes very complex and maintaining the matrix files becomes too difficult.
OPTIONS	
EXAMPLE SCRIPT	MATH: V200=10 / *dimension of x* MATH: V201=20 / *dimension of y* MATRIXOPEN: V999 V200 V201 “MISREG1.MTX” ::: MATH: V300=10 MATH: V301=40 ::: MATRIXOPEN: V1234 V300 V301 “MISREG2.MTX” MATRIXVALUE: V999 1 1 V202 MATRIXVALUE: V1234 1 1 V302 MATH: V400 = V202 != V302 JUMP: V400 CONFUSION ::: ::: MEASURE: 2 ::: MATRIXCLOSE:V999 MATRIXCLOSE:V1234 MARK: GOODEXIT EXIT: ::: ::: MARK: CONFUSION MATRIXCLEAR: EXIT:
RELATED SCRIPTS	MATRIXOPEN, MATRIXWRITE, MATRIXCLOSE

MATRIXCLOSE

NAME	MATRIXCLOSE - close and free matrix resources
FUNCTION	MATRIXCLOSE: Vhndl
USE	Frees memory occupied by the matrix and releases the handle
OPTIONS	Vhndl Script variable V00-V99 used for the handle in MATRIXOPEN
EXAMPLE SCRIPT	MATRIXCLOSE: V200

MATRIXOPEN

FUNCTION

MATRIXOPEN - open and read matrix file
MATRIXOPEN: Vhndl dimx dimy "file.ext"

USE

Open a matrix and read in dimx * dimy values

OPTIONS

Vhndl	Matrix *handle#* assigned to matrix (max 20)
dimx dimy	Number of rows and columns in matrix
"file.ext"	Filename of matrix file (max 10 chars)

EXAMPLE SCRIPT

sample.mtx

```
39, 12
0,  45
88, 9
-3, 15
```

```
MATRIXOPEN:  V80   2   4   "sample.mtx"
MATRIXSET:     V80   1   3   17
MATRIXWRITE: V80  "output.mtx"
MATRIXCLOSE: V80
```

output.*mtx*

```
39, 12
0,  45
17, 9
-3, 15
```

MATRIXSET

FUNCTION	MATRIXSET - Set a value into an opened matrix MATRIXSET: Vhndl Vx Vy Vnum
USE	Sets a value into a matrix cell
OPTIONS	Vhandl Script variable, V00-V99 used in the MATRIXOPEN as the handle Vx Matrix column, 1-dimx, matrix cell address Vy Matrix row, 1-dimy, matrix cell adress Vnum Value to be placed into matrix cell
EXAMPLE SCRIPT	MATH: V01=1 MATRIXSET: V80 2 V01 100 *sets cell at row 1, col 2 to 100* MATRIXSET: V80 2 V01 V01 *sets cell at row 1, col 2 to 1*

MATRIXVALUE

FUNCTION	MATRIXVALUE: Get matrix value at x,y into Vnum MATRIXVALUE: Vhndl Vx Vy Vnum
USE	Get the value of a matrix cell into a script variable
OPTIONS	Vhndl script variable, V00-V99 used in the MATRIXOPEN as the handle Vx,Vy matrix col, row = cell address to retrieve from Vnum script variable, V00-V99 to receive the value

MATRIXWRITE

FUNCTION	MATRIXWRITE - save matrix to disk as a file MATRIXWRITE Vhndl "file.ext"
USE	Write values of matrix to disk as a file of dimy lines
OPTIONS	Vhndl Matrix *handle#* assigned to matrix (maximum 20) "file.ext" filename of matrix file (maximum 10 characters)
NOTE	Use MATRIXCLOSE to free the handle and memory
EXAMPLE SCRIPT	

sample.mtx

```
39, 12
0,  45
88, 9
-3, 15
```

```
MATRIXOPEN:  V80   2   4   "sample.mtx"
MATRIXSET:     V80   1   3   17
MATRIXWRITE: V80  "output.mtx"
MATRIXCLOSE: V80
```

output.*mtx*

```
39, 12
0,  45
17, 9
-3, 15
```

RELATED SCRIPTS	MATRIXOPEN; MATRIXSET; MATRIXCLEAR; MATRIXCLOSE

MEASURE

FUNCTION	MEASURE: Vpause Measure and pause for Vpause (default =1) seconds afterwards
USE	Actually initiates a mesaurement on the currently active sequence window setup
EXAMPLE SCRIPT	MEASURE:1
RELATED SCRIPTS	SEQWIN; MSR_STATS; MSR_DEFAULT; MSR_ERROR; RESULT

MEASURE_ALGORITHM

FUNCTION	MEASURE_ALGORITHM: Type Vaaa, Vbbb, Vccc, Vddd, Veee TYPE=AVERAGE Vaaa=MIN THRESHOLD Vbbb=PIXELWIDTH @ MIN THRESHOLD Vccc=MAX THRESHOLD Vddd=PIXELWIDTH @ MAX THRESHOLD Veee=MEASUREMENT THRESHOLD
USE	Allows the user to define in the script the type of measurement algorithm to use either the standard method or the optional method for use with phase shift masks and resist coated masks. The command, when set for the optional method, allows the user to define the maximum threshold and associated pixel width, the minimum threshold and associated pixel width, and the measurement threshold. This command supersedes the SEQEDGE threshold detection criteria.
EXAMPLE SCRIPT	MEASUREALGORITHM: AVERAGE 10 30 95 30 35
RELATED SCRIPTS	MEASURE, SEQEDGE

MENU

FUNCTION	MENU:Vnum, [“title str”,] "Option-1", "Option-2"
USE	Allows the script to prompt the operator with a list of choices; returns the number of the “choice” in Vnum, which can then be used in a series of MATH: JUMP: statements
EXAMPLE SCRIPT	MENU:V66"SELECT PRODUCT TYPE" "Wxx 3 SITE","Txx 3 SITE","Pxx 3 SITE” MATH:V67=V66=1 JUMP:V67 NANO2 MATH:V67=V66=2
RELATED SCRIPTS	MATH: JUMP: CALL:

MESSAGE

FUNCTION	MESSAGE: put 'text string' on message line MESSAGE: “text string”
USE	Displays the text string on the screen message line area
EXAMPLE SCRIPT	MESSAGE: “COUNTDOWN = %”, V99
RELATED SCRIPTS	MENU; OPERATOR

METER

FUNCTION	METER:Vnum
USE	Places the average illumination of the area enclosed in the RP_WIN into the variable Vnum
EXAMPLE SCRIPT	MARK:CHECK RP_WIN:302 215 340 245 METER:V87 MATH:V86=V87<600 MATH:V85=V87>650 CALL:V85 DECREASE LOOP:V85 CHECK CALL:V86 INCREASE LOOP:V86 CHECK LUMREAD:GV44 OV45
RELATED SCRIPTS	LUMREAD: LUMSET: RP_WIN

MOT_Z_MOVE

FUNCTION	MOT_Z_MOVE:V_z
USE	Moves the column to position V_z in .001 um units
EXAMPLE SCRIPT	MOT_Z_MOVE:40192
RELATED SCRIPTS	MOT_Z_REL; Z_MOVE; Z_REL

MOT_Z_REL

FUNCTION	MOT_Z_REL:V_z
USE	Allows the script to position the column relative to the current position
EXAMPLE SCRIPT	GET_Z:V29 MATH:V39=V29-9500 MOT_Z_REL:V39 PAUSE:2 Z_MOVE:9500 PAUSE:1
RELATED SCRIPTS	MOT_Z_MOVE, GET_Z, GET_MOT_Z

MOVEPOL

FUNCTION	MOVEPOL:V_x V_y
USE	Move to stage position V_x , V_y in the aligned/deskewed coordinate system.
EXAMPLE SCRIPT	MARK:SITESCAN MATH:V01=0 MARK:NEXTPOS MATH:V01=V01+1 MATRIXVALUE:V00 1 V01 V02 MATRIXVALUE:V00 2 V01 V03 MATRIXVALUE:V00 3 V01 V04 MATRIXVALUE:V00 4 V01 V05 MATRIXVALUE:V00 5 V01 V06 MATH:V15=V02=0 JUMP:V15 EXITSCAN MOVEPOL:V02 V03 PAUSE:2 CALL:1 POLELOCATION
RELATED SCRIPTS	MOVEPOLZ; RELMOVE; REL_POL; REL_POLZ

MOVEPOL_NM

FUNCTION	MOVEPOL_NM:V_x V_y
USE	Move to stage position V_x , V_y in the aligned/deskewed coordinate system. 100 nanometer resolution (.1 um)
EXAMPLE SCRIPT	MARK:SITESCAN MATH:V01=0 MARK:NEXTPOS MATH:V01=V01+1 MATRIXVALUE:V00 1 V01 V02 MATRIXVALUE:V00 2 V01 V03 MATRIXVALUE:V00 3 V01 V04 MATRIXVALUE:V00 4 V01 V05 MATRIXVALUE:V00 5 V01 V06 MATH:V15=V02=0 JUMP:V15 EXITSCAN MOVEPOL_NM:V02 V03 PAUSE:2 CALL:1 POLELOCATION
RELATED SCRIPTS	MOVEPOLZ; RELMOVE; REL_POL; REL_POLZ

MOVEPOLZ

FUNCTION	MOVEPOLZ: V_x V_y
USE	Move to stage position V_x , V_y in the aligned/deskewed and planarized coordinate system.
EXAMPLE SCRIPT	MARK:SITESCAN MATH:V01=0 MARK:NEXTPOS MATH:V01=V01+1 MATRIXVALUE:V00 1 V01 V02 MATRIXVALUE:V00 2 V01 V03 MATRIXVALUE:V00 3 V01 V04 MATRIXVALUE:V00 4 V01 V05 MATRIXVALUE:V00 5 V01 V06 MATH:V15=V02=0 JUMP:V15 EXITSCAN OVEPOLZ:V02 V03 PAUSE:2 CALL:1 POLELOCATION
RELATED SCRIPTS	MOVEPOL; RELMOVE; REL_POL; REL_POLZ

MOVEPOLZ_NM

FUNCTION	MOVEPOLZ_NM: V_x V_y
USE	Move to stage position V_x , V_y in the aligned/deskewed and planarized coordinate system. Nanometer resolution (100nm = .1 micron); essentially yields one more digit of stage accuracy, to .1 micron
EXAMPLE SCRIPT	MARK:SITESCAN MATH:V01=0 MARK:NEXTPOS MATH:V01=V01+1 MATRIXVALUE:V00 1 V01 V02 MATRIXVALUE:V00 2 V01 V03 MATRIXVALUE:V00 3 V01 V04 MATRIXVALUE:V00 4 V01 V05 MATRIXVALUE:V00 5 V01 V06 MATH:V15=V02=0 JUMP:V15 EXITSCAN MOVEPOLZ_NM:V02 V03 PAUSE:2 CALL:1 POLELOCATION
RELATED SCRIPTS	MOVEPOL; RELMOVE; REL_POL; REL_POLZ

MSR_DEFAULT

FUNCTION	MSR_DEFAULT: Vvalue
USE	Number to report as the default measurement if an error occurs; used often to flag for a measurement problem in the system
EXAMPLE SCRIPT	MSR_DEFAULT:99999
RELATED SCRIPTS	MSR_STATS; MEASURE; MSR_ERROR

MSR_ERROR

FUNCTION	MSR_ERROR: Verr [Vseq]
USE	Gets the error flag (Verr) for sequence Vseq 0 - no error, 1 - Out of range High, 2 - out of range Low, 3 - other error, 4 - user aborted
EXAMPLE SCRIPT	MEASURE:1 RESULT:5 V88 //:CHECK FOR MEASUREMENT ERROR (999999), RETURN 0 IF OK,RETURN 1 IF ERROR //:IF ERROR EXECUTE "REPEAT" ROUTINE, THAT REFOCUS,REPOSITION STAGE //:AND REPEAT THE MEASUREMENT MSR_ERROR:V50 5 MATH:V50=V50>0 MATH:V08=V07>3 CALL:V08 NOMORE CALL:V50 REPEATPOLE
RELATED SCRIPTS	MSR_STATS; MEASURE; MSR_DEFAULT

MSR_STATS

FUNCTION	MSR_STATS:Vnum
USE	Sets the data collection register for the measure command (0 - 9). All data will be placed in the register Vnum, as well as the statistics being gathered.
EXAMPLE SCRIPT	MSR_STATS:5 RECALL:5 V30 V27 LUMSET:GV44 OV45 MEASURE:1 RESULT:5 V88
RELATED SCRIPTS	MSR_ERROR; MEASURE; MSR_DEFAULT

OPERATOR

FUNCTION	OPERATOR: ["Message"]
USE	Pauses script processing and allows the operator to perform some manual control; displays the optional message that can be used to instruct the operator as to what task needs to be performed
EXAMPLE SCRIPT	OPERATOR: "Align and focus"
RELATED SCRIPTS	MESSAGE; MENU

OPMARK

FUNCTION	OPMARK: MARKER
USE	Label for CALL, JUMP, LOOP and operator's 'GOTO OPMARK' OPMARK's are seen in the GOTO menu under the script processing icon; allows a handy way to test a subroutine without running the entire script
EXAMPLE SCRIPT	OPMARK:TEST_POLE_MEASUREMENT
RELATED SCRIPTS	CALL; JUMP; LOOP

ORIGIN

FUNCTION	ORIGIN:
USE	Sets the local mask origin (or the aligned ORIGIN) to the current location; useful for using matrix files containing absolute coordinates from a reference point
EXAMPLE SCRIPT	ORIGIN:
RELATED SCRIPTS	DESKEW; MASK_ORIGIN

PATREC_FIND

FUNCTION

PATREC_FIND - find a pattern matching model
PATREC_FIND: [Vrotate] [Vcenterx Vcentery Vwidth Vheight] “filename”

Vrotate	Rotate model 90 degrees counterclockwise
Vcenterx	x pixel position of the center of the search window
Vcentery	y pixel position of the center of the search window
Vwidth	width of search window
Vheight	height of search window
filename	filename of pattern model

USE

Finds a matching pattern for the model specified in the file. The format of the model in the file must be either MIL, BMP, or TIF. The extension in the filename indicates the format type. The extension is “.BMP” for bit map, “.MMO” for the Matrox MIL format, and “.TIF” for TIF. These are the only formats supported at this time. If no optional parameters are specified the KMS software will search over the entire image area. The search may be narrowed by specifying a rectangular area. The center pixel of the rectangle is defined by its x and y location on the screen. The rectangle also requires the width and height. Another option which may be specified is the rotation for the model. If a non-zero value is specified, then the model will be rotated 90 degrees counter-clockwise. Besides the filename, there should only be 1, 4 or 5 optional parameters specified in the command line.

OPTIONS

EXAMPLE SCRIPT

```
MATH: V01=1                         //sequence #1
RECALL: V01
MATH: V1200 = 1                     //Rotate model
PATREC_FIND:  V1200  “MYMOD.MMO”
                                    //Matrix MIL format
                                    //search entire image
PATREC_GET: V1201 V1202 V1203       //Get results
MATH: V200 = 320                    //Center pixel x
MATH: V201 = 240                    //Center pixel y
MATH: V202 = 200                    //width of rectangle
MATH: V203 = 300                    //height of rectangle
PATREC_FIND: V200 V201 V203 V204 “MYMOD.BMP”
                                    //BMP format
                                    //search limited area
:::
:::
EXIT:
```

RELATED SCRIPTS

PATREC_GET, PATREC_SAVE,PATREC_SHOW

PATREC_GET

FUNCTION	PATREC_GET - retrieve results pattern match PATREC_GET: Vcenterx Vcentery Vscore Vcenterx The x pixel position of the center of the pattern Vcentery The y pixel position of the center of the pattern Vscore Matching score as a percentage
USE	Retrieve the results from the last PATREC_FIND. A score of 100 would be a perfect match. A score of 80 or higher would a typical score. If no pattern is found, then a zero score would be reported. Also, if a zero score is returned, then the x and y pixel positions will also be zeroes. The returned center x and y values are each multiplied by 1000.
OPTIONS	
EXAMPLE SCRIPT	::: ::: PATREC_FIND: “SQUARE.BMP” PATREC_GET: V1200 V1201 V1202 MESSAGE: “Center x = %”, V1200 MESSAGE: “Center y = %”, V1201 MESSAGE: “Score = %”, V1202 ::: ::: EXIT:
RELATED SCRIPTS	PATREC_FIND, PATREC_SAVE, PATREC_SHOW

PATREC_SAVE

FUNCTION	PATREC_SAVE - save a pattern matching model in a file PATREC_SAVE: “filename” Filename file to store the pattern matching model
USE	Saves a pattern matching model in one of three formats: MIL, BMP, or TIF. The pattern to be saved is defined by the left measure window’s location and size on the screen. The width of the measure window must be at least 24 pixels but no more than 256 pixels. The height of the measure window must be at least 24 pixels and no more than 240 pixels. The format is automatically determined by the extension of the filename. The MIL format is a Matrix format and the file extension must be “.MMO”. The BMP format is the bit map format and the file extension must be “.BMP”. For the TIF format the file extension must be “.TIF”. These three formats are the only ones supported at this time.
OPTIONS	
EXAMPLE SCRIPT	MATH: V01=1 //sequence #1 RECALL: V01 PATREC_SAVE: “MYMOD.TIF” //Save in TIF format ::: ::: EXIT:
RELATED SCRIPTS	PATREC_FIND, PATREC_GET, PATREC_SHOW

PATREC_SHOW

FUNCTION	Display a pattern matching model PATREC_SHOW: “filename” Filename name of the file that holds the pattern matching model
USE	Display in the center of the screen the pattern matching model. The center of the model should coincide with the center of the screen. Three file formats are supported at this time: MIL, BMP, and TIF. Files with the extension “.MMO” are defined to have models in the Matrox MIL format. Files with the extension “.BMP” are defined to have models in the BMP format. Files with the extension “.TIF” are defined to have models in the TIF format. Files with any other extension are not valid at this time.
OPTIONS	
EXAMPLE SCRIPT	MATH: V01=1 //sequence #1 RECALL: V01 PATREC_SHOW: V1200 ::: ::: EXIT:
RELATED SCRIPTS	PATREC_FIND, PATREC_GET, PATREC_SAVE

PAUSE

FUNCTION	PAUSE: Vseconds
USE	Pauses Vseconds number of seconds. Useful to make sure that the stage is steady before making readings or doing pattern recognition.
EXAMPLE SCRIPT	PAUSE:7

PICSHOW

FUNCTION	PICSHOW:Vx Vy “Filename”
USE	Loads image file “Filename” and displays it on the screen with the top left corner at Vx,Vy
EXAMPLE SCRIPT	PICSHOW:40 100 “image.bmp”
RELATED SCRIPTS	PICTURE: PICTURETIFF: PICTUREVGA:

PICTURE

FUNCTION	PICTURE:Vx1 Vy1 Vx2 Vy2 “Filename”
USE	Saves the video in the box defined by Vx1 Vy1 Vx2 Vy2 to “filename” as a .BMP file.
EXAMPLE SCRIPT	PICTURE:40 100 600 480 “image.bmp”
RELATED SCRIPTS	PICSHOW: PICTURETIFF: PICTUREVGA:

PICTURETIFF

FUNCTION	PICTURETIFF:Vx1 Vy1 Vx2 Vy2 “Filename”
USE	Saves the video in the box defined by Vx1 Vy1 Vx2 Vy2 to “filename” as a .TIF file.
EXAMPLE SCRIPT	PICTURETIFF:40 100 600 480 “image.tif”
RELATED SCRIPTS	PICSHOW: PICTURE: PICTUREVGA:

PICTUREVGA

FUNCTION	PICTUREVGA:Vx1 Vy1 Vx2 Vy2 “Filename”
USE	Saves the video and VGA overlay in the box defined by Vx1 Vy1 Vx2 Vy2 to “filename” as a .BMP file
EXAMPLE SCRIPT	PICTUREVGA:40 100 600 480 “image.tif”
RELATED SCRIPTS	PICSHOW: PICTURE: PICTURETIFF:

PLANECALC

FUNCTION	PLANECALC:
USE	Calculates the plane defined by the three PLANEPT:'s. Allows Z-axis correction when making stage moves under script control. Very useful in confocal mode as it allows large moves while keeping the sample co-planar with the plane of focus.
EXAMPLE SCRIPT	PLANECALC:
RELATED SCRIPTS	PLANEPT:

PLANEPT

FUNCTION	PLANEPT:[1|2|3] Defines the three points needed for a plane calculation that allows Z-axis adjustments when moving the stage.
USE	Used by the software to calculate a plane where the substrate is in focus. Allows freedom to move the stage while maintaining a constant focus plane. The three points should be roughly 60 degrees apart and as far from each other as possible on the stage.
EXAMPLE SCRIPT	PLANEPT:1
RELATED SCRIPTS	PLANECALC:

POSMOVE

FUNCTION	POSMOVE:V_x V_y
USE	Move the stage to V_x V_y in unaligned microns. Micron resolution
EXAMPLE SCRIPT	POSMOVE:61232 -36917
RELATED SCRIPTS	POSMOVE_NM: POSPOL: POSPOL_NM:

POSMOVE_NM

FUNCTION	POSMOVE_NM: V_x V_y
USE	Move the stage to V_x V_y in unaligned nanometers; actually moves in 1/10 micron (or 100 nm) steps on the stage.
EXAMPLE SCRIPT	POSMOVE_NM:61232 -36917
RELATED SCRIPTS	POSMOVE_NM: POSPOL: POSPOL_NM:

POSPOL

FUNCTION	POSPOL: V_x V_y
USE	Get mask position into V_x V_y in aligned microns; micron resolution.
EXAMPLE SCRIPT	POSPOL:61232 -36917
RELATED SCRIPTS	POSMOVE_NM: POSPOL: POSPOL_NM:

POSPOL_NM

FUNCTION	POSPOL_NM: V_x V_y
USE	Get mask position into V_x V_y in aligned nanometers; 100 nanometer resolution.
EXAMPLE SCRIPT	POSPOL_NM:61232300 -36917400
RELATED SCRIPTS	POSMOVE_NM: POSPOL: POSPOL_NM:

PRINT

FUNCTION	PRINT: "text string"
USE	Output text to the logfile; useful to output data directly to the logfile.
EXAMPLE SCRIPT	PRINT:”The linewidth was : %”,V87
RELATED SCRIPTS	PRINTSTR: GETTEXT: TEXT

PRINTER

FUNCTION	PRINTER: [0|1] 0 = off; 1 = on
USE	Toggles data into logfile echoed to printer
EXAMPLE SCRIPT	PRINTER:0

PRINTSTR

FUNCTION	PRINTSTR: "TextStr"
USE	Output test to logfile, but NOT a Cr/Lf; useful for building a format into a logfile.
EXAMPLE SCRIPT	PRINTSTR: "Readings were: %,",V91
RELATED SCRIPTS	PRINT: GETTEXT: TEXT

PROGNUM

FUNCTION	PROGNUM:Vprognum
USE	Gets the currently loaded program; allows script to be “aware” of program being used
EXAMPLE SCRIPT	PROGNUM:V32
RELATED SCRIPTS	LOADPROG: LOADCF: LOADCALIB

QUIT

FUNCTION	QUIT:
USE	Terminate script execution and reset to beginning.
EXAMPLE SCRIPT	QUIT:
RELATED SCRIPTS	END: EXIT:

RECALL

FUNCTION	RECALL: Vnumber [Vx Vy]
USE	Recall setup 0-9 from program, at offset Vx, Vy.
EXAMPLE SCRIPT	RECALL:5 V27 V30
RELATED SCRIPTS	SEQWIN

RECPT

FUNCTION	RECPT:Vpt Vaxis Vdir Vedge Vthresh
USE	Vpt = [0-9], Vaxis = [0 = Horiz, 1 = Vert], Vdir = [0 = neg, 1 = pos], Vedge = [1-99] , Vthresh = [% threshold]
EXAMPLE SCRIPT	RP_WIN:150 300 500 350 RECPT:0 0 1 1 50 RECPT:1 0 1 2 50 RP_EXEC:0 2 RP_READ:0 V20 RP_READ:1 V22
RELATED SCRIPTS	RP_WIN, RP_EXEC, RP_READ

RELMOVE

FUNCTION	RELMOVE:Vx Vy
USE	Move stage by Vx Vy microns.
EXAMPLE SCRIPT	RELMOVE:-1 3
RELATED SCRIPTS	POSMOVE: POSPOL: MOVEPOLZ:REL_POL: REL_POLZ

RELMOVE_NM

FUNCTION	RELMOVE_NM:Vx Vy
USE	Move stage by Vx Vy nanometers (100 nm resolution) Machine divides by 100 and uses .1 micron (or 1000 nanometers) as the minimum stage move increment.
EXAMPLE SCRIPT	RELMOVE_NM:-1100 3200
RELATED SCRIPTS	POSMOVE: POSPOL: MOVEPOLZ:REL_POL: REL_POLZ

REL_POL

FUNCTION	V_x V_y
USE	Move relative position in aligned and deskewed coordinate system (in 1 microns).
EXAMPLE SCRIPT	RELPOL: 15 10
RELATED SCRIPTS	RELPOLZ; RELPOL_NM

REL_POL_NM

FUNCTION	REL_POL_NM:Vx Vy
USE	Move stage by Vx Vy nanometers in the aligned (or ‘polar’) coordinate frame. Machine divides by 100 and uses 1/10 micron as the minimum stage move increment.
EXAMPLE SCRIPT	REL_POL_NM:-1300 3600 Moves stage -1.3,3.6 microns.
RELATED SCRIPTS	POSMOVE: POSPOL: MOVEPOLZ:REL_POL: REL_POLZ

REL_POLZ

FUNCTION	REL_POLZ:Vx Vy
USE	Move stage by Vx Vy microns in the aligned (or ‘polar’)coordinate frame, Z - compensated.
EXAMPLE SCRIPT	REL_POLZ:-1 3
RELATED SCRIPTS	POSMOVE: POSPOL: MOVEPOLZ:REL_POL: REL_POLZ

REL_POLZ_NM

FUNCTION	REL_POLZ_NM:Vx Vy
USE	Move stage by Vx Vy nanometers in the aligned (or ‘polar’) coordinate frame, Z-compensated. Stage resolution is 100 nm, i.e., minimum step is 0.1 micron.
EXAMPLE SCRIPT	REL_POLZ_NM:-1300 3400
RELATED SCRIPTS	POSMOVE: POSPOL: MOVEPOLZ:REL_POL: REL_POLZ

RESULT

FUNCTION	RESULT:Vmsr Vnum
USE	Gets the last measurement result from Vmsr and stores it in Vnum
EXAMPLE SCRIPT	RESULT:1 V87
RELATED SCRIPTS	MEASURE: MSR_DEFAULT:, MSR_STATS:

RETURN

FUNCTION	RETURN:
USE	RETURN's from a CALLed subroutine. Resumes execution at the statement following the CALL statement that transferred control.
EXAMPLE SCRIPT	RETURN:
RELATED SCRIPTS	CALL:, JUMP:, LOOP:

RP_DISPLAY

FUNCTION	RP_DISPLAY: [0|1] 0 = Do not save data; 1 = Save data
USE	For TIC debugging use. Shows the averages of the pixel values within the RP_WIN. If 1, then save the data in SUMX.DAT and SUMY.DAT.
EXAMPLE SCRIPT	RP_DISPLAY:1
RELATED SCRIPTS	CALL:, JUMP:, LOOP:

RP_EXEC

FUNCTION	RP_EXEC:Vstart Vnum
USE	Execute the setup pattern recognition starting with RECPT Vstart and the following Vcnt RECPT's.
EXAMPLE SCRIPT	RP_EXEC:0 3
RELATED SCRIPTS	RP_WIN:, RP_READ:, RECPT:

RP_READ

FUNCTION	RP_READ:Vptnum Vpixel
USE	Reads the results from the last RP_EXEC of point Vptnum into the variable Vpixel.
EXAMPLE SCRIPT	RP_READ:1 V23
RELATED SCRIPTS	RP_WIN:, RP_EXEC:, RECPT:

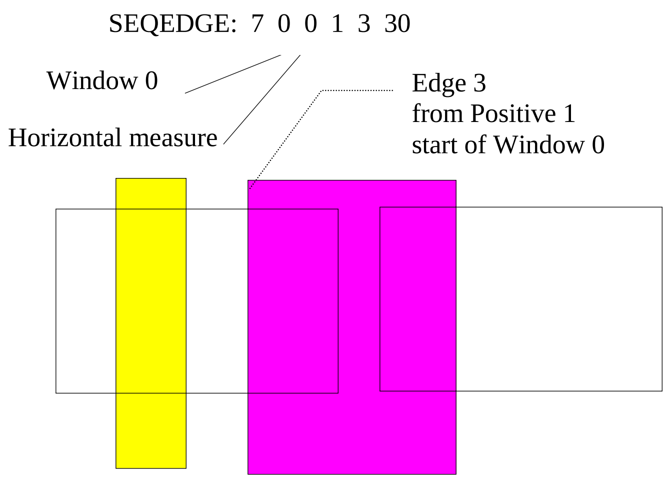
RP_WIN

FUNCTION	RP_WIN: Vx1 Vy1 Vx2 Vy2
USE	Establishes the window to use to perform pattern recognition
EXAMPLE SCRIPT	RP_WIN:50 100 590 120
RELATED SCRIPTS	RP_EXEC:, RP_READ:, RECPT:

SEQEDGE

FUNCTION	SEQEDGE: Vseq Vwin Vaxis Vdir Vedge Vth
	Vseq Sequence number, 0-9
	Vwin Measure window: 0 for top or left 1 for bottom or right
	Vaxis Measure 0 for horizontal, 1 for vertical
	Vdir 0 for negative direction, 1 for positive
	Vedge Edge number from neg/pos side of window, 1-100
	Vth Threshold percentage for edge detection
USE	50% threshold assumed unless overridden using Ctrl-t.
EXAMPLE SCRIPT	Figure 6-8 is an example of a sequence edge number script.
RELATED SCRIPTS	SEQWIN; RECALL

Figure 6-8. Example of a Sequence Edge Number Script



SEQNAME

FUNCTION	SEQNAME:Vseq[0-9] “Text String”
USE	Set name of measure sequence Vseq
EXAMPLE SCRIPT	SEQNAME:1 “X-Axis Measurement”
RELATED SCRIPTS	SEQWIN:, SEQEDGE:

SEQOUTPUT

FUNCTION

SEQOUTPUT - select measurement output type
SEQOUTPUT: Vseq Voutput_type

Vseq	Sequence (0-9)
Voutput_type	Measurement output type (0-2) 0 = mean 1= min 2= max

USE

Selects the measurement output type for a sequence

OPTIONS

EXAMPLE SCRIPT

```
MATH: V01=1                //sequence #1
MATH: V1200 = 5
SEQOUTPUT: V01 1           //minimum output
RECALL: V01
MEASURE:  V1200
:::
:::
EXIT:
```

RELATED SCRIPTS

SEQEDGE, SEQWIN

SEQWIN

FUNCTION	SEQWIN:Vseq Vwin Vx1 Vy1 Vx2 Vy2
USE	Establishes the window to use to perform measurements. Vseq[0-9] is the sequence number to be used: Vwin[0|1] left/right window, Vx1 Vy1 Vx2 Vy2 top left and bottom right corners of the window.
EXAMPLE SCRIPT	SEQWIN:3 0 100 100 300 160
RELATED SCRIPTS	SEQEDGE:, SEQNAME:

SETSTOP

FUNCTION	Vstopnum V_x V_y
USE	Set stop to V_x, V_y in coordinate system (in 1 microns).
EXAMPLE SCRIPT	SETSTOP: 31 65400 1300
REALTED SCRIPTS	GOSTOP:, GETSTOP

SHOWPIC

FUNCTION	SHOWPIC:Vx Vy “filename”
USE	Load saved image and display with upper left corner at Vx, Vy.
EXAMPLE SCRIPT	SHOWPIC:100 100 SLICE.BMP
RELATED SCRIPTS	PICTURE:, PICTUREVGA:, PICTURETIFF

SILENT

FUNCTION	SILENT:[0|1]
USE	Toggles silent script operation; speeds script processing by ~1/3
EXAMPLE SCRIPT	SILENT:1
RELATED SCRIPTS	COMMENT: 11:11:1, DEBUG

SITENAME

FUNCTION	SITENAME: "text string"
USE	Sets the measurement site name to “Text String”
EXAMPLE SCRIPT	SITENAME:"Pole Location"
RELATED SCRIPTS	SEQNAME

SPAWN

FUNCTION	SPAWN:command [parameters]
USE	Execute DOS command with parameters. Can be used to run a DOS mode batch file for data transfer issues.
EXAMPLE SCRIPT	SPAWN:COPYIT.BAT
RELATED SCRIPTS	GSPAWN:

START

FUNCTION	START:
USE	Restarts the script from the beginning
EXAMPLE SCRIPT	START:
RELATED SCRIPTS	END: EXIT: QUIT:

STATEDGE

FUNCTION	STATEDGE:Vedge[0|1] Vmax Vmin Vavg Vcnt Vsdev
USE	Measure edge statistics

STATMSR

FUNCTION	STATEDGE:Vreg[1-10] Vmax Vmin Vavg Vcnt Vsdev
USE	Get statistics for measurement register Vreg
EXAMPLE SCRIPT	STATMSR:1 V10 V11 V12 V13 V14
RELATED SCRIPTS	MEASURE: MSR_STATS: MSR_DEFAULT:

STATMSR3

FUNCTION	Get statistics for a sequence window/collector STATMSR3: Vseq[0-9] Vmax Vmin Vavg Vcnt Vsdev Vseq Sequence window number/collector Vmax Maximum measured value in the collector Vmin Minimum measured value in the collector Vavg Average value of all the measurements Vcnt Number of measurements collected Vsdev 3 sigma standard deviation
USE	Retrieves the statistics for the specified collector. Returns maximum measurement, minimum measurement, average measurement, number of measurements, and a 3 sigma value for standard deviation. The lsd of the standard deviation for STATMSR3 is one thousandth of a nanometer. STATMSR3 and STATMSR differ only in the standard deviation returned. STATMSR returns one sigma and the lsd is one nanometer.
OPTIONS	N/A
EXAMPLE SCRIPT	MATH: V3298=2 /select collector #2 SEQWIN: V3298 1 100 100 200 200 SEQWIN: V3298 0 125 125 175 175 MEASURE: 3 STATMSR3 V3298 V12 V13 V14 V15 V16 MESSAGE: “3 SIGMA STD DEV = %”, V16 ::: EXIT:
RELATED SCRIPT	STATMSR

STATS

FUNCTION	STATS - functions for measurement statistics *Register[s]* STATS: D|O|P|C|0|1
USE	User control of statistics registers 0-9. Discard, Operator, Print, Clear, 0:off, 1:on
OPTIONS	**D** Discard**O** Operator menu **P** Print statistics for stat registers 0-9 **C** Clear stat registers **0** Off **1** On
RELATED SCRIPTS	MSR_STATS, STATMSR

TEXT

FUNCTION	TEXT:Vx Vy Vcolor “String”
USE	Displays the “string” at the Vx Vy position of the screen with the color Vcolor.
EXAMPLE SCRIPT	TEXT:100 100 2 “Run % of 100”,V51
RELATED SCRIPTS	PRINT: PRINTSTR:

TIME

FUNCTION	TIME:Vnum
USE	Places the time machine has been in operation in variable Vnum (Time /10 in seconds)
EXAMPLE SCRIPT	TIME: V57
RELATED SCRIPTS	DATE:; CLOCK

TURRET

FUNCTION	TURRET:Vpos[1-5]
USE	Moves turret nosepiece to the position Vpos
EXAMPLE SCRIPT	TURRET:1

TURRETFF

FUNCTION	TURRETFF: Enable and disable fast focus for turret moves TURRETFF: [0|1] 0 Disable fast focus 1 Enable fast focus
USE	For KMS 400 systems only, fast focus for turret moves may be enabled and disabled with this command. The fast focus feature is designed primarily to help bring the target into view in confocal mode when the illumination may be inadequate. Fast focus for turret moves can be manually enabled or disabled in the Program Setup screen of the KMS program, and its status is maintained as a global in the SYSTEM.CFG file.
OPTIONS	
EXAMPLE SCRIPT	TURRETFF: 1 // Enable fast focus TURRET: 2 MESSAGE: "FIND FIDUCIAL" TURRET: 3 TURRETFF: 0 // Disable fast focus MESSAGE: "FIND ALIGN POINT" ::: RELMOVE: 80000 0 MESSAGE: "FIND SKEW POINT" ::: :::

TURRETPOS

FUNCTION	TURRETPOS: Vnum
USE	Reads current turret position and returns the value to the variable Vnum.
EXAMPLE SCRIPT	TURRETPOS: V300 MATH: V301=V300=3 CALL: V301 100X_MEASURE
RELATED SCRIPTS	TURRET, TURRETFF

UPDATE

FUNCTION	UPDATE:
USE	Updates the realtime display information
EXAMPLE SCRIPT	UPDATE:
RELATED SCRIPTS	ERASE; CLEARPIC

XHAIR

FUNCTION	XHAIR:[0|1]
USE	Toggles the display of the cross hair at the center of the display.
EXAMPLE SCRIPT	XHAIR:1
RELATED SCRIPTS	LINE; BOX

Z_MOVE

FUNCTION	Z_MOVE: Vz
USE	Moves the piezo to Vz in nanometers.
EXAMPLE SCRIPT	Z_MOVE:13000
RELATED SCRIPTS	Z_REL: MOT_Z_MOVE:, MOT_Z_REL

Z_REL

FUNCTION	Z_REL:Vz
USE	Moves the piezo Vz nanometers from the current position.
EXAMPLE SCRIPT	Z_REL:1500
RELATED SCRIPTS	Z_MOVE:, MOT_Z_MOVE:, MOT_Z_REL:

7 Operation

Overview

This chapter provides detailed instructions for using the KMS-310/400 software in supervisor mode.

Note: For an overview of the supervisor software screens, screen components and software controls, refer to *Chapter 4: User Interface*.

This chapter is organized into the following sections (Figure 7-1):

- *Overview*, which provides an overview of the chapter's organization and procedures contained in each chapter section.
- *Access and Exit the Supervisor Master Menu Screen*, which provides procedures for accessing the Supervisor Master Menu screen, returning to the Standby screen and exiting to DOS.
- *Setup a Program*, which provides procedures for creating, copying and deleting programs, setting the operator lockouts, configuring sequence setup options, measure windows setup and program measurement options.
- *Measure*, which provides procedures for measuring edges in manual, semi-automatic and fully automatic modes.
- *Manage Measurement Data*, which provides procedures for managing measurement statistics and ID entries, as well as configuring data maps.

Figure 7-1. Chapter 7 Overview

Access the Supervisor Master Menu screen

Access the Supervisor master Menu screen

Return to the Standby screen

Exit to DOS

Set up a program

Access the Select Program window

Open, copy, create or delete a program

Define program parameters

Set operator lockouts

Set up measurement sequences

Set up measurement windows

Select measurement options

Set up measurement axis

Measure

Access the Production menu

Load a plate

Select a new program (optional)

Change ID entries (optional)

Clear statistics (optional)

Measure in manual mode

Measure in semi-auto mode

Measure in auto mode

Manage measurement data

Manage statistics

Manage ID entries

Configure a data map

Access and Exit the Supervisor Master Menu Screen

This section provides instruction for accessing and exiting the Supervisor Master Menu screen, and consists of the following sections:

- Access the Supervisor Master Menu Screen
- Return to the Standby screen
- Exit to DOS

Access the Supervisor Master Menu Screen

In idle mode, the KMS-310/400 system displays the Standby screen (Figure 7-2). When the system is first turned on, *Production* is highlighted as the default selection. Both production and supervisor software modes are accessed from this screen.

To access the Supervisor Master Menu screen:

1. Highlight *Supervisor* and press [SELECT] (Figure 7-2).

Note: When you are finished working in supervisor mode, always return to the Standby screen to prevent access to supervisor mode operations by unqualified personnel.

Figure 7-2. Standby Screen

A message displayed at the bottom of the Standby Screen prompts you to enter your four character access code (Figure 7-3).

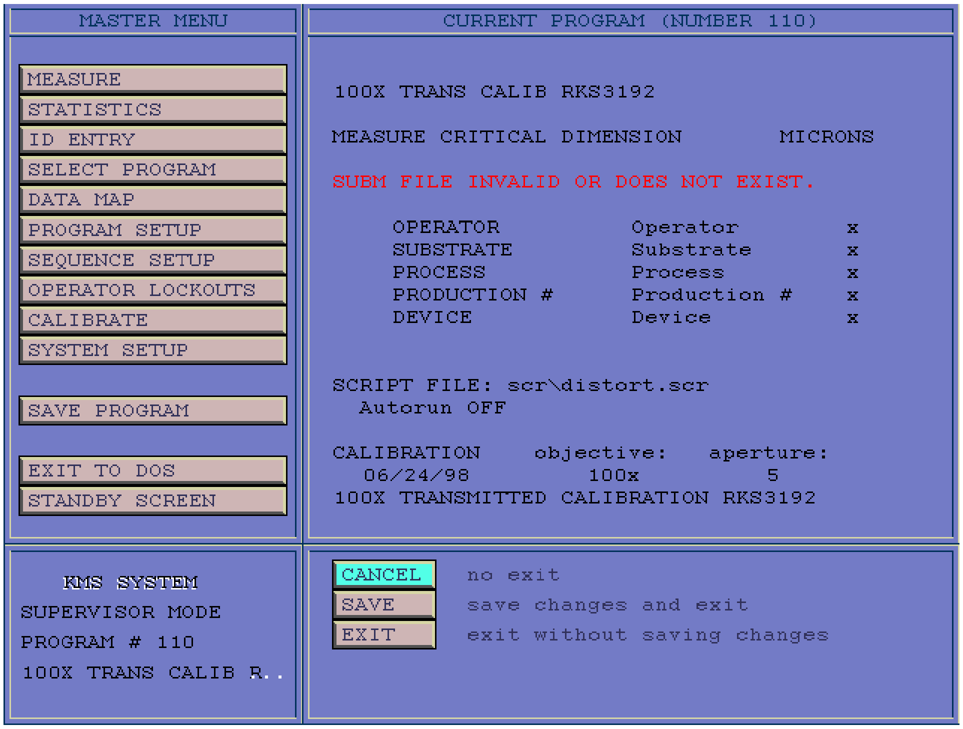
Note: Only qualified personnel can enter the *Supervisor* Mode, because any changes made in this mode are permanent and control the *Production* Mode of operation for each program. For this reason, an access code is required when entering the *Supervisor* Mode. This code is initially assigned by Zygo but may be changed by the user.

Figure 7-3. Supervisor Access Code Screen.

2. Type in your access code and press [SELECT].

The Supervisor Master Menu screen is then displayed (Figure 7-4).

Figure 7-4. Supervisor Master Menu Screen



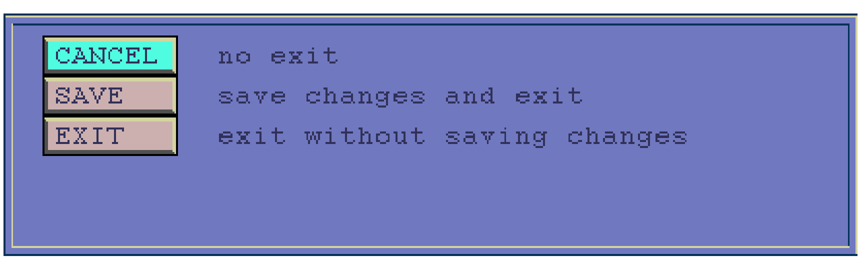
Return to Standby Screen

To return to the Standby screen:

1. From the Master Menu screen, select Standby Screen.

   The Return to Standby Screen subwindow is displayed below the Current Program window (Figure 7-5).

Figure 7-5. Return to Standby Subwindow



2. To return to the Supervisor Master Menu screen, select *Cancel* or press [ESC].
3. To save changes and exit to the Standby screen, select *Save.*
4. To exit to the Standby screen without saving changes, select *Exit.*

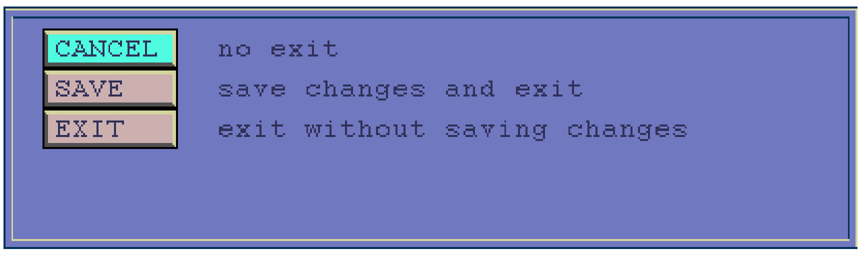
Exit to DOS

To exit the Supervisor Master Menu screen and exit to DOS:

1. From the Master Menu screen, select *Exit to DOS*.

   The Exit to DOS subwindow is displayed below the Current Program screen (Figure 7-6).

Figure 7-6. Exit to DOS Screen



2. To return to the Supervisor Master Menu screen, select *Cancel* or press [ESC].
3. To save changes and exit to DOS, select *Save*.
4. To exit to DOS without saving changes, select *Exit*.

Set up a Program

This section provides instructions for creating a measurement program. You can create a new program or copy an existing program and make modifications.

This section provides procedures for:

- accessing the Select Program window
- opening an existing program
- copying an existing program
- creating a new program
- deleting a program
- defining program parameters
- setting operator lockouts
- configuring sequence setup
- setting up measurement window functions
- selecting measurement options
- setting up the measurement axis

Creating program templates will simplify the setup of subsequent programs, making it necessary to program multiple criteria only one time while setting up programs. This will save time and ensure that all parameters are set in each program.

Note: A program setup is valid for one objective only. Therefore, each objective must be calibrated separately and set up as a template.

Access the Select Program Screen

To access the Select Program screen:

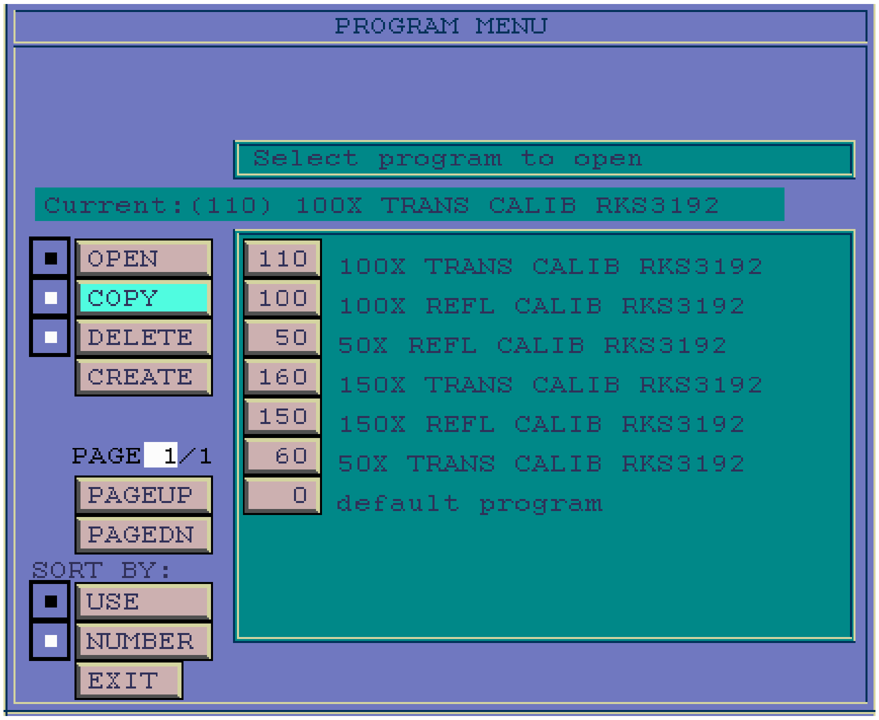
1. From the Master menu screen, select *Select Program*.

   The Program Menu window (Figure 7-7) is displayed, listing the programs in the order they were previously used from top to bottom.

2. To sort programs by previous usage or program number, select SORT BY and choose a method of sorting.

3. Use the *PageUp* and *PageDn* commands to display different pages of the program list.

Figure 7-7. Select Program Menu Screen



Open an Existing Program

To select and open an existing program:

1. With the Select Program window displayed, select *Open*.
2. Highlight the number associated with the desired program.

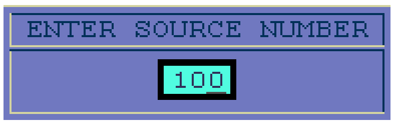
   The selected program id displayed at the top of the Program Menu window with the number highlighted.
3. Press [ESC], or highlight [OPEN] and press [SELECT], to display the Source File subwindow (Figure 7-8).

Figure 7-8. Source File Subwindow

   The *Select From List* button is highlighted.
4. Press [SELECT] to open an existing file from the list.
5. Highlight the *Enter File Number* button and press [SELECT].

   The Enter Source File subwindow. (Figure 7-9) is displayed.

Figure 7-9. Enter Source File Subwindow



6. Enter the number of the program file (up to three digits) and press [SELECT].

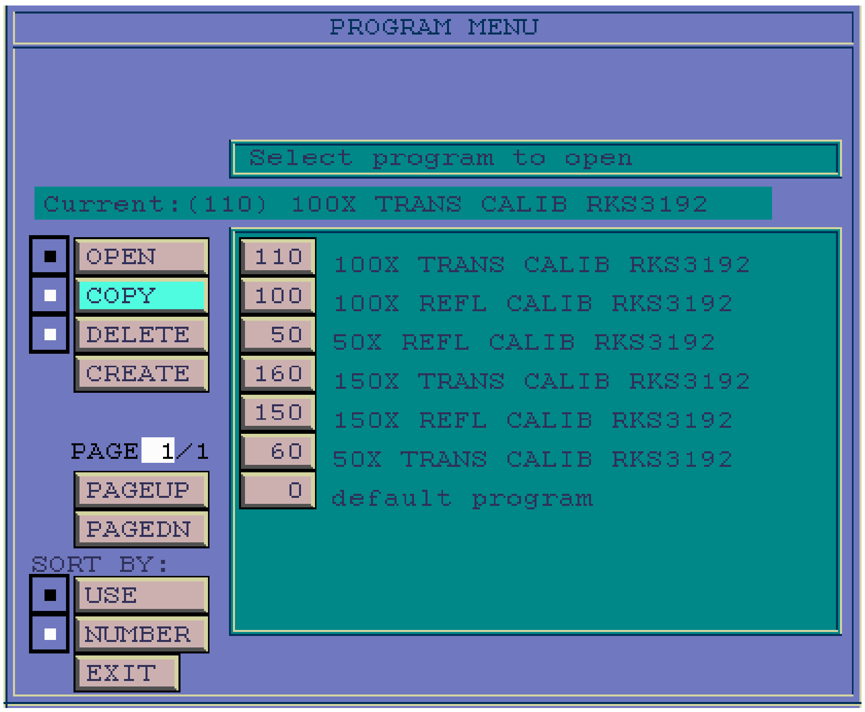
   If the program number that you entered does not exist, an error message is displayed.
7. To return to the Program menu, press [SELECT].
8. Press [ESCAPE] when you have finished making changes to the program.

Copy an Existing Program

To copy an existing program:

1. From the Select Program screen, highlight *Copy* and press [SELECT].
2. Highlight the number of the program you want to copy and press [SELECT].
3. Enter a new program name for the copy you made.
4. Press [ESC] to return to the Program menu.

Figure 7-10. Program Menu Window



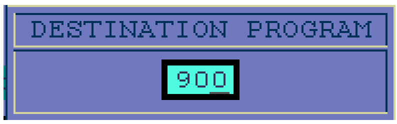
Create a New Program

To create a new program:

1. From the Program Menu screen, select *Create*.

   The Destination Program subwindow is displayed (Figure 7-11). A new program is opened at the top of the list and is named with the current date and time. Initially, the program contains system default information, which is changed as you perform the remaining setup procedures.

Figure 7-11. Destination Program screen



2. Press [ESC] to return to the Supervisor Master Menu window.

Delete a Program

Caution*:* Use *Delete* carefully. If you select a program number after highlighting *Delete*, the program (with its calibration and stage stops) will be lost. Although it is possible to retrieve the program from DOS, this is complicated due to the additional requirements of updating the AMS300-H.DAT (history) file.

To delete an existing program:

1. From the Select Program screen, select *Delete*.
2. Highlight the number associated with the program you want to delete, then press [SELECT].

   If the *Delete* option is selected, the program is deleted.
3. Press [ESC] or [EXIT] when the delete function is completed to return to the Supervisor Master Menu screen.

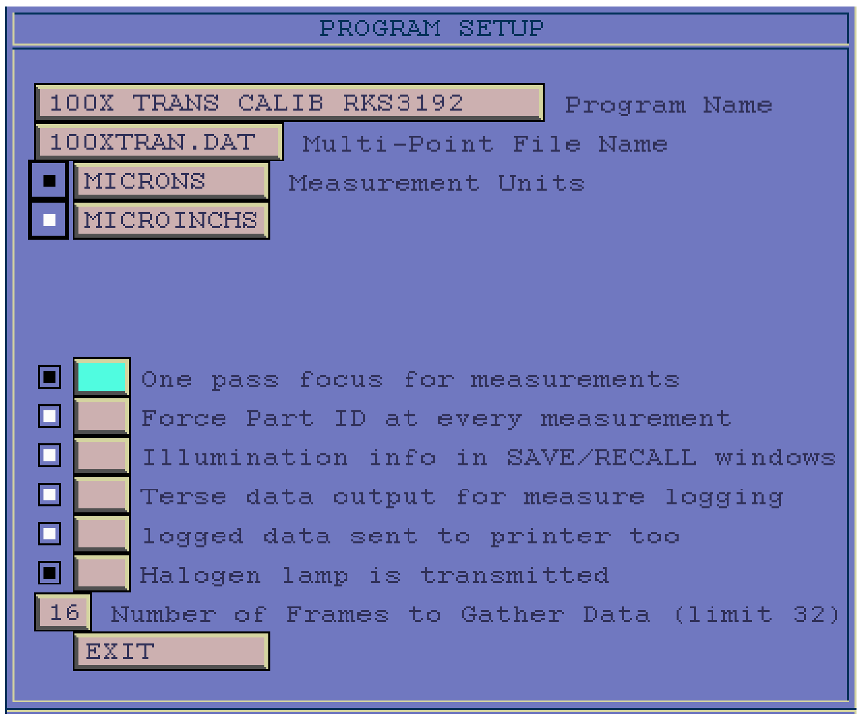
Define Program Parameters

To name the program and set up program parameters:

1. From the Supervisor Master Menu screen, select *Program Setup*.

   The Program Setup window is displayed (Figure 7-12).

Figure 7-12. Program Setup Window



2. To change the displayed program name, type a new name in the *Program Name* field and press [SELECT].

Note: A program name should identify the substrate to be measured or the purpose of the program. For example, since this will be a reference program for both setup and calibration information, use a name such as 'CALIBRATION 100X OBJECTIVE STD NO. 3054' (your standard number).

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3. To change the displayed multi-point file name press [SELECT], then type a new name in the *Multi-Point File Name* field and press [SELECT].
4. To select the Measurement Units, highlight either the *Microns* or *Microinches* button and press [SELECT].
5. To force a part ID at every measurement, toggle on that selection.

6. To include Illumination info in the Save/Recall windows, toggle on that selection.

   When you select the *Illumination info in SAVE/RECALL windows* option, different values can be saved into the 10 window setups.

7. To select the Terse data output for measure logging, toggle on that selection.
8. To send logged data to the printer too, toggle on that selection.
9. To work in the transmitted mode, toggle on this selection.
10. To type in the number of frames you wish to be averaged (limit 32), toggle on that selection. The default value is 16.
11. To return to the Supervisor Master Menu, select *Exit*.

Set Operator Lockouts

This option allows you to lock out program setups so that an operator cannot change or use them. The items which can be locked out are:

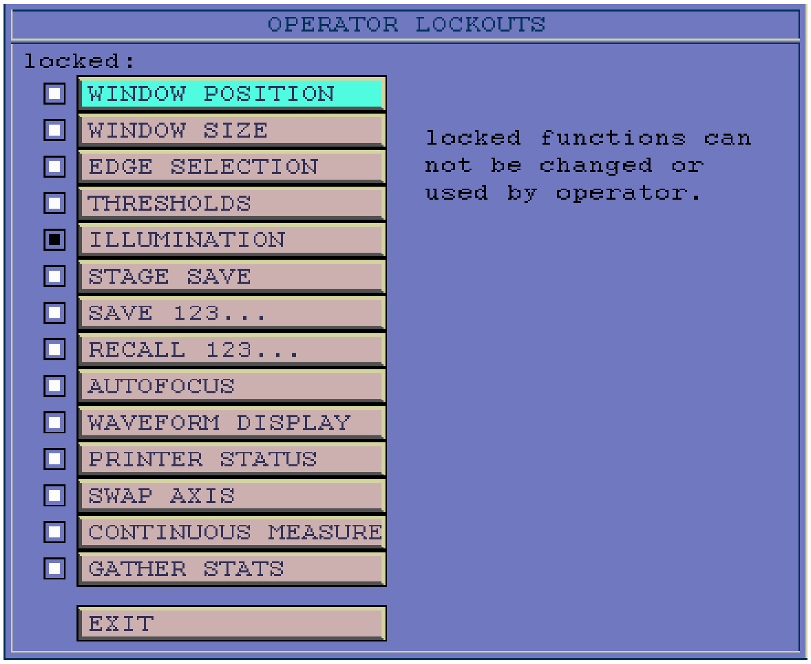
- Window position
- Window size
- Edge selection
- Thresholds
- Illumination
- Stage save
- Save 123.,..
- Recall 123…
- Autofocus
- Waveform display
- Printer status
- Swap axis
- Continuous measure
- Gather stats

To display the Operator Lockouts screen:

1. From the Supervisor Master Menu screen, highlight *Operator Lockouts* and press [SELECT].

The Operator Lockouts screen (Figure 7-13) is displayed, listing the setup functions for the program.

Figure 7-13. Operator Lockouts Screen



2. To lockout options, select the item to lock out, and toggle on.

Repeat the previous step for each item you wish to lock out.

Note: When the Measure screen is entered while in production mode, any icon or button that has been locked out will have a black diagonal line through it and is not functional.

---

3. To return to the Supervisor Master Menu, select *Exit* and press [SELECT], or press [ESC].

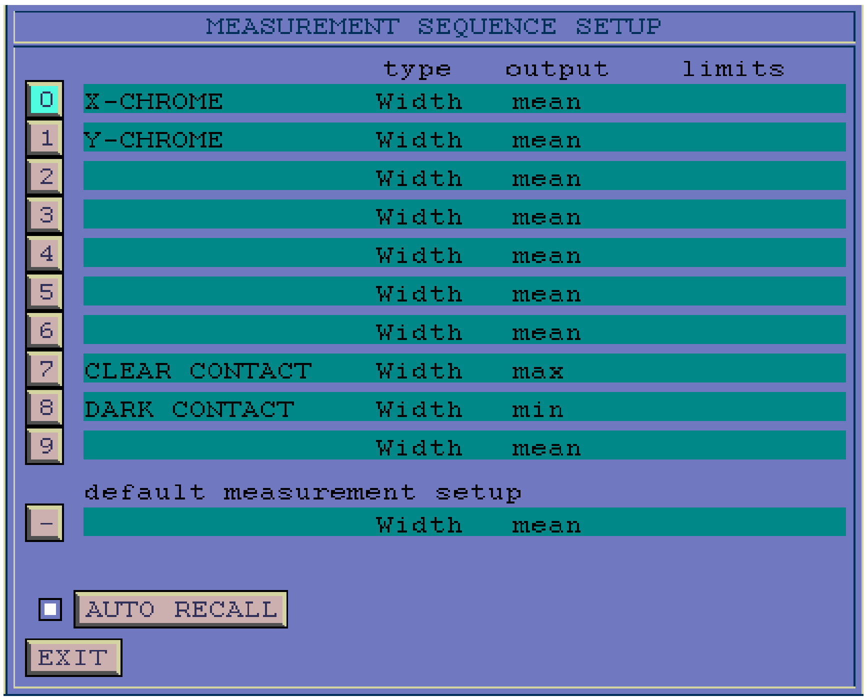
Set up Measurement Sequences

To set up a measurement sequence:

1. From the Supervisor Master Menu screen, select *Sequence Setup*.

   The Measurement Sequence Setup window is displayed (Figure 7-14). This screen lists the window setups that must be saved using the Save/Recall icon in the Measure screen during program setup.

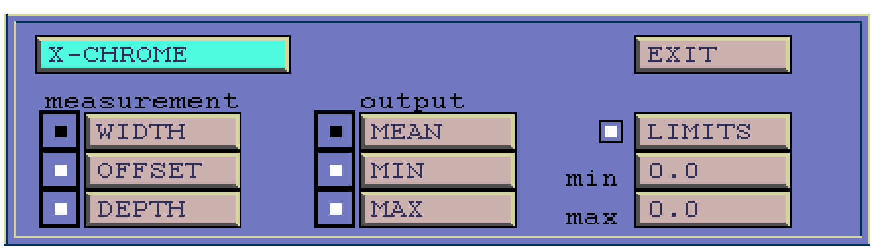
Figure 7-14. Measurement Sequence Setup Window



2. Highlight the save/recall number you want to be the first entry in the sequential reading and press [SELECT].

   The Measurement Sequence Setup subwindow is displayed (Figure 7-15).

Figure 7-15. Measurement Sequence Setup Subwindow



3. To name any data collected:
    a. Highlight a number.
    b. Press [SELECT].
    c. Type the name in the *Default* field.
    d. Press [ESC].
4. To select the type of measurement to be made, select either *Width* or *Depth*.
5. To permit offset measurements, select *Offset* and toggle on.
6. Select the output as *Mean*, *Min*, or *Max*.
7. To set and define limits, select *Limits* and enter upper (max) and lower (min) acceptance limit values.

    The operator will be warned by the system if the reading is incorrect based on the value entered in the *Limits* field.
8. To return to the Measurement Sequence Setup screen to change information for another program, press [EXIT].
9. To turn auto recall on or off, select *Auto*.
10. To save the information and return to the Supervisor Master Menu screen, select *Save Program*.

Note: Be sure to save all program changes into the final save/recall/ sequence setup position within the Measure screen and save the program in the Supervisor Master Menu screen before exiting the program. These two steps must be done regardless of whether the measurement sequence setup is saved before or after the window setup in the Measure screen.

Set Up the Measurement Window

This section provides instructions for setting up and selecting program measurement window options, and consists of the following procedures:

- Adjust window control
- Setting the window position
- Superimposing windows
- Separating windows
- Creating butted windows
- Set window size
- Set window thresholds
- Set window edges
- Save window configuration

Adjust Window Control

Four icons on the Measure screen control the setup of measurement functions of the windows:

- Position
- Size
- Threshold
- Edge

There are two measuring windows:

- Left and Right for horizontal measurements
- Top and Bottom for vertical measurements

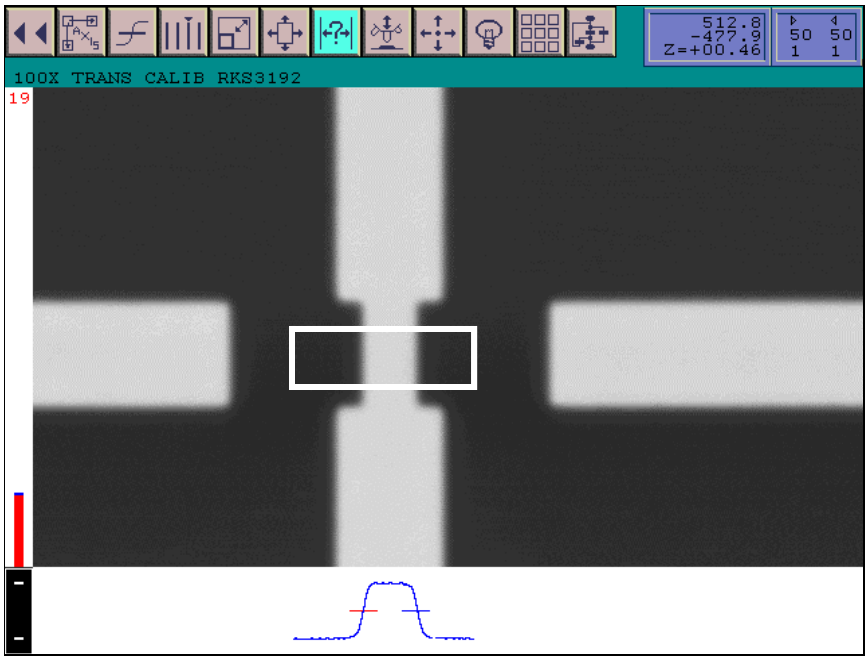
When one of the above icons is selected, you may control both of these windows at the same time, or you may control either window individually. An indication of which window (or both) is being controlled appears at the upper right portion of the screen:

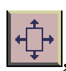
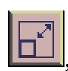
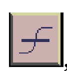
To adjust window control:

1. From the Supervisor Master Menu screen, select *Measure*.

   The Measure window is displayed (Figure 7-16).

Figure 7-16. Measure Screen

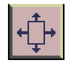


2. Press [SELECT] when the , , , or  is highlighted.

Set the Window Position

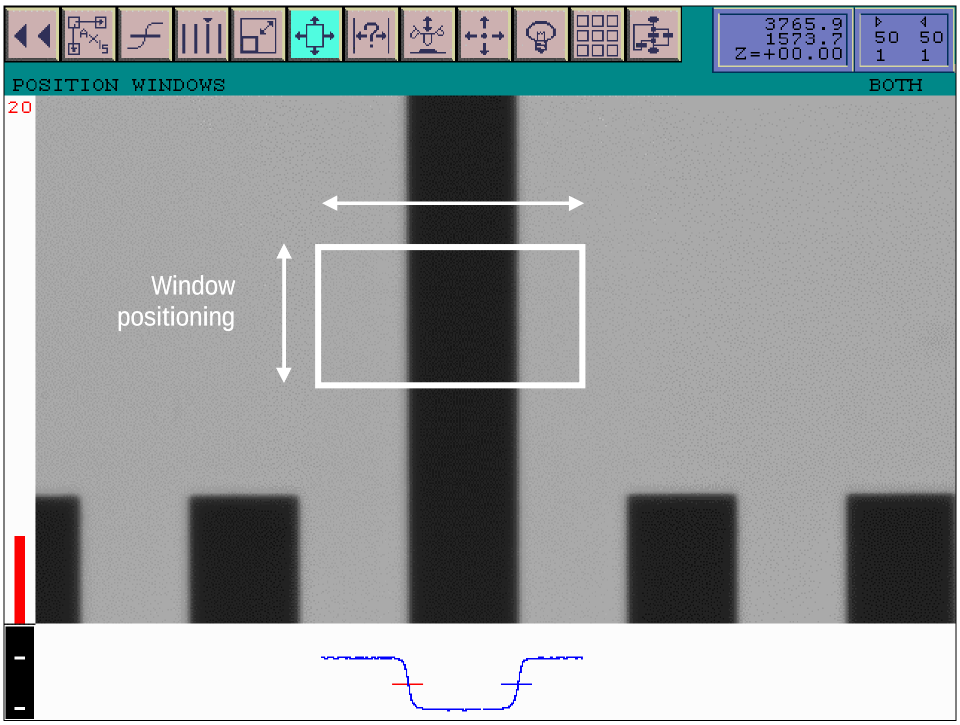
When you position the two windows, the middle (center scan line) of the windows (horizontal or vertical) must overlay the object to be measured. This center scan line is used to draw the image intensity profile at the bottom of the screen.

To position the windows:

1. From the Measure screen, highlight the  icon and press [SELECT].

   The Window Position subscreen is displayed (Figure 7-17).

Figure 7-17. Window Position Subscreen

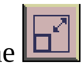


2. Use the ↑ and ↓ keys to position the windows in relation to each other as superimposed, separated or butted.
3. To return to the Measure screen press [ESC].

Set Window Size

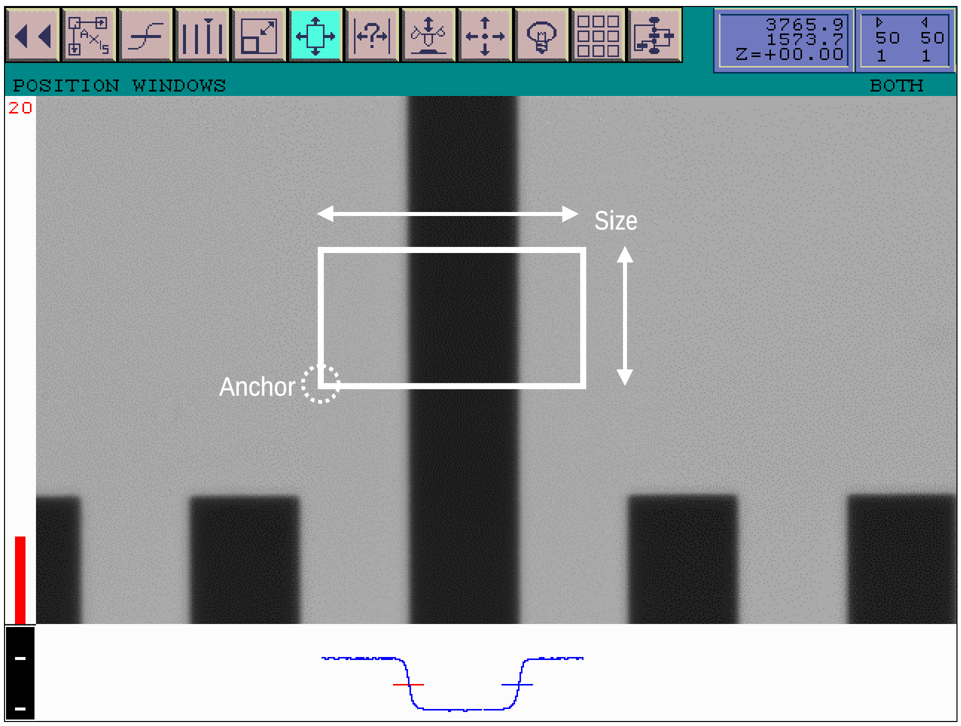
To ensure accurate measurement, either edge of the window must overhang the image by at least 1/8 inch.

To change the size of a window:

1. From the Measure screen, select the  icon and press [SELECT].

   The Window Size Icon Subscreen is displayed (Figure 7-18).

Figure 7-18. Window Size Icon Subscreen



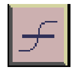
2. Use the ↑ and ↓ keys to reduce or increase the size of the windows.
3. To exit the Window Size subscreen and return to the Measure screen press [ESC].

Set Window Thresholds

For most substrates, the recommended threshold for the left and right windows is 50 percent. For metal-in-gap magnetic heads, however, the detection threshold on the left window should be approximately 16 percent. For other devices, such as phase-shift photo resist coated masks, both thresholds should be the same percentage, since the substrates are symmetrical.

Note: Before setting the thresholds, you must set focus, illumination, window position and window size.

To set window thresholds:

1. From the Measure screen, select the  icon and press [SELECT].

   The Threshold Icon subscreen is displayed with *both* displayed at the top right corner of the screen.

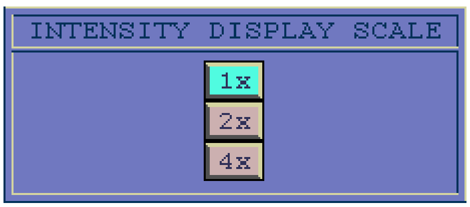
2. Use the ↑and ↓ arrow keys to set the thresholds based on which edges you want to detect (from 0 to 100 percent).

   Changes in the threshold are displayed in the top right corner of the screen.

3. To adjust the intensity display scale press [ESC], then [MENU].

   The Intensity Display Scale Menu Subscreen is displayed (Figure 7-19).

Figure 7-19.Intensity Display Scale



4. Highlight 1x, 2x, or 4x and press [SELECT].

5. To exit the Intensity Display Scale subscreen press [ESC].

6. To exit the Threshold Icon subscreen and return to the Measure screen, press [ESC].

Set Window Edges

Setting the edges to be measured and saving the window setup is the final step in the calibration setup procedures.

To set window edges:

1. From the Measure screen, Highlight the  icon and press [SELECT].

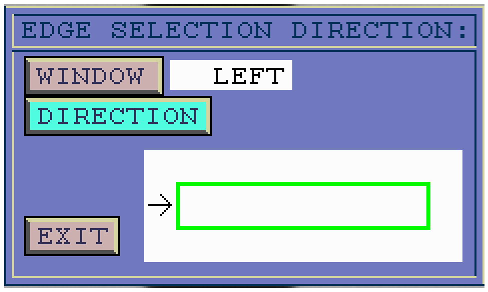
   The Edge Selection Icon subscreen is displayed.

2. Use the → and ← arrow keys to move the edges of both windows.

3. To change the edge detection direction for individual windows press [ESC], then [MENU].

The Edge Selection Direction subscreen menu is displayed (Figure 7-20), with the *Window* and *Left* buttons highlighted. The highlighted *Left* button indicates that edge selection will be made from the left window.

Figure 7-20.Edge Selection Direction Menu Subscreen



4. To change the direction control of the right window press [SELECT].
5. To change the direction back to the left window, highlight the [DIRECTION] button and press [SELECT].

Note: As you change directions from left to right, or vice versa, the small arrow at respective sides of the rectangle shown in the Menu changes from one side to the other. For the following description, when these settings are completed, the left window should count line edges from its left side and the right window should count line edges from its right side.

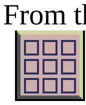
---

6. To exit the Edge Selection Direction menu press [ESC].

   The Edge Selection icon remains highlighted and *Both* appears near the top right corner of the screen.

Save the Window Configuration

To save the window setup:

1. From the Measure screen, with the cursors indicating the proper line, highlight the  icon and press [SELECT].

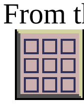
   The Save/Recall Icon subscreen is displayed (Figure 7-21).

Figure 7-21. Save/Recall Icon Subscreen

2. In the submenu highlight the number you want to assign the setup to and press [SELECT].
3. Highlight the *Name* text field, type a name for the window setup and press [ESC].
4. To save the setup, select *Save* in the submenu and press [SELECT].

   The window setup (including position, size, edges, threshold, illumination and measurement axis) is now saved as the number you just selected and can be recalled at any time by highlighting the number and selecting *Recall*.
5. To return to the Measure screen press [ESC].

To save the window setup for a clear space:

1. From the Measure screen, with the cursors indicating the proper line, highlight the  icon and press [SELECT].

   The Save/Recall Icon subscreen is displayed (Figure 7-22).

Figure 7-22.Save/Recall Icon Subscreen

2. In the submenu highlight the number you want to assign the setup to and press [SELECT].
3. Highlight the *Name* text field, type a name for the window setup and press [ESC].
4. To save the setup, select *Save* in the submenu and press [SELECT].

   The window setup (including position, size, edges, threshold, illumination and measurement axis) is now saved as the number you just selected and can be recalled at any time by highlighting the number and selecting *Recall*.
5. To return to the Measure screen press [ESC].
6. To return to the Supervisor Master Menu screen press [ESC].
7. Highlight *Save Program* and press [SELECT] to save all changes for the measurement windows to the specified program.

Note: The Save/Recall icon may also be used to save measurement axes for later recall.

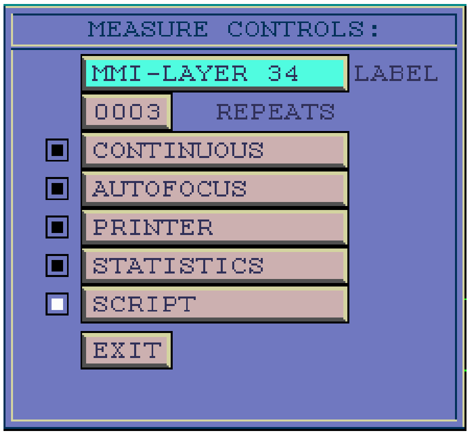
Select Measurement Options

To select measurement options:

1. With the Measure screen displayed, press [MENU].

   The Measure Controls dialog box (Figure 7-23) is displayed.

Figure 7-23. Measure Controls Dialog Box



2. To identify the measurement for printing to a log file, enter a name or number in the *Label* field and press [SELECT].
3. If you want to make multiple measurements without operator entry, enter the number of measurements in the *Repeats* field.

Note: The *Repeats* selection is used in automatic mode only. It is used primarily for testing system repeatability on a particular substrate (usually the calibration standard). This test should be done after significant changes have been made to the system's configuration, or if the pattern being measured is not within process specifications.

---

4. If you entered a value in the *Repeats* field, select *Continuous.*

   If the *Continuous* button is selected and no value is entered into the *Repeats* field, the system performs repetitive measurements until the [ESC] key is pressed. (Configuring a program in this manner is not recommended.)
5. Select *Autofocus.*

   Autofocus must be turned on to ensure accurate or repeatable measurements can be made.
6. Select *Printer* to send the measurement data to the hard disk, printer or a host computer.
7. Select *Statistics* to make measurement statistics available for viewing after a program has been run.

This *Statistics* selection is only necessary for repetitive measurements on a single substrate or group of substrates.

8. Select *Script* to choose a script routine.

   The last script run and residing in the Program Setup screen will be involved if this option is selected. The script will start when the *Measure* icon is selected in the measure screen.

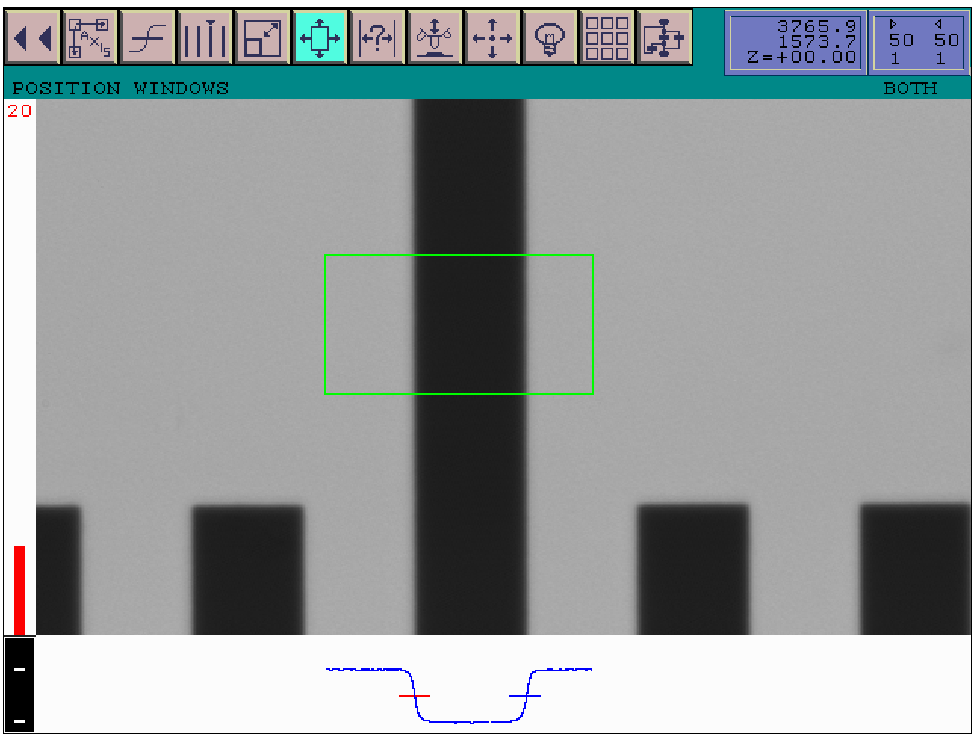
9. To exit the Measure screen, select *Exit* or press [ESC].

Set Up the Measurement Axis

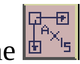
The image intensity profile is the middle scan line taken across the active area of both windows in either axis. The image intensity profile is a curve that represents graphically the intensity changes that occur on the substrate that are defined by the measure windows.

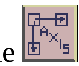
For horizontal measurements, the image intensity profile is displayed from left to right at the bottom of the screen (Figure 7-24). For vertical measurements, the image intensity profile appears from top to bottom at the right of the screen.

Figure 7-24. Image Intensity for Horizontal Measurements



To change the axis from horizontal to vertical, or from vertical to horizontal:

1. From the Measure screen, highlight the  icon and press [SELECT] to toggle the axis between vertical and horizontal.

2. Press either the right or left arrow key to exit the  icon.

Measure

This section provides procedures for accessing the Production Menu screen and measuring edges in manual, semiautomatic and fully automatic modes.

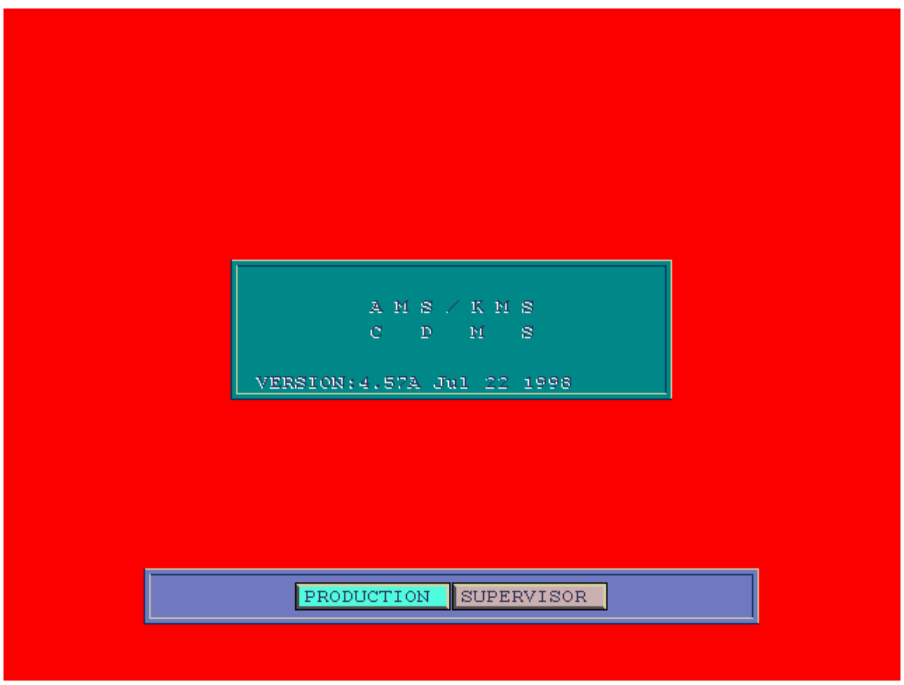
Access the Production Menu

Note: When idle, the Standby screen is the default display for the system (Figure 7-25). When this screen is displayed, the system is ready for immediate use. If the Standby screen is not displayed, you will need to initialize the system from a cold start.

To access the Production main menu:

1. With the Standby screen displayed (Figure 7-25), select *Production* and press [SELECT].

Figure 7-25. KMS-310/400 Standby Screen



The Production main menu and screen are then displayed (Figure 7-26). The following data is displayed along the bottom portion of the screen:

- program name
- previously-entered ID information
- objective and microscope aperture to be used for measurement

Figure 7-26. Production Main Menu and Screen

Load a Plate

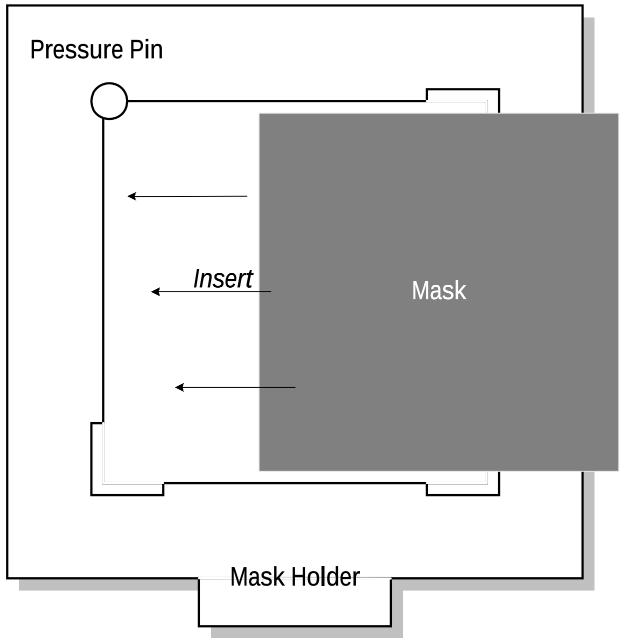
Caution: Focus correctly at 10X or you may crash the objective and/or substrate at higher magnifications.

To load a plate onto the stage:

1. Position the mask so with the titles right side up (chrome side up).
2. Grab the right side of the mask with either a mask pick or your hand.

3. Align the mask with the mask holder so that the right side of the mask lines up with the right side of the mask holder (Figure 7-27).

Figure 7-27. Loading a Plate on the Stage

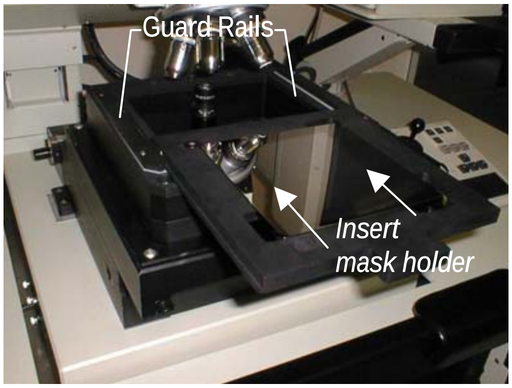


4. Gently push the mask to the left so that the round pressure pin (in the upper left corner of the mask holder) is pushed out of the way.
5. Gently push the mask down into the mask holder so that it rests on the support rails of the mask holder.

6. Insert the mask holder into the guide rails of the stage and gently push the plate in to the backstop (Figure 7-28).

Caution: To avoid injury due to pinch points on the stage, exercise caution when loading the plate onto the stage.

Figure 7-28. Loading a Mask into the Stage



Select a New Program (Optional)

The program used for the last measurement is displayed at the bottom of the Production Main Menu screen. If you want to continue using this program, you do not need to perform the steps in this section. Perform the steps in this section only if you want to select a new measurement program.

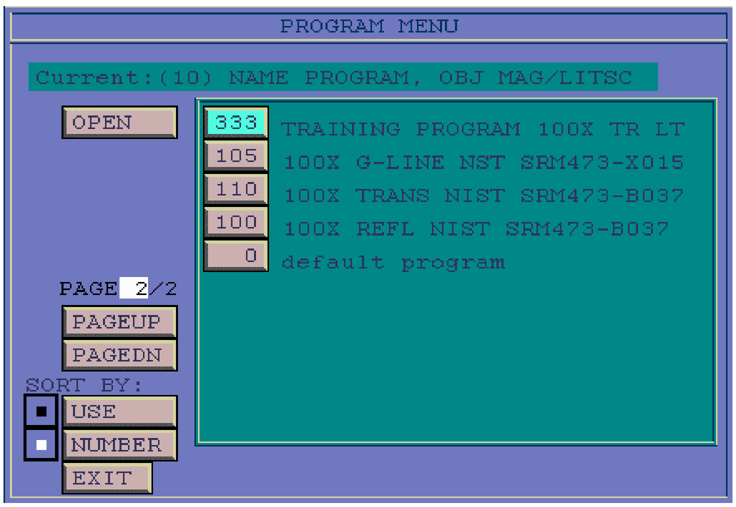
Note: Each program contains calibration values for a unique magnification. For this reason, you can only use the objective specified on the bottom of the Operator Main Menu screen. If you use a different magnification your measurements will not be valid.

To select a new measurement program:

1. With the Production Main Menu screen displayed, highlight *Program* and press [SELECT].

   The Program Menu Setup dialog box is displayed (Figure 7-29).

Figure 7-29. Program Menu Setup Dialog Box



2. If you want to sort the programs, highlight either the [USE] or [NUMBER] selection and press [SELECT].
3. If there is more than one page of program listings, use the [PAGEUP] and [PAGEDN] buttons to display the previous or next page of program listings.
4. Highlight the program number you want to use and press [SELECT].

Note: Instead of performing Steps 5 - 7, you can simply press [ESC] to enable the selected program.

5. Select a program name and number.
6. Highlight the [OPEN] button and press [SELECT].
7. Highlight the [EXIT] button and press [SELECT].

Change ID Entries (Optional)

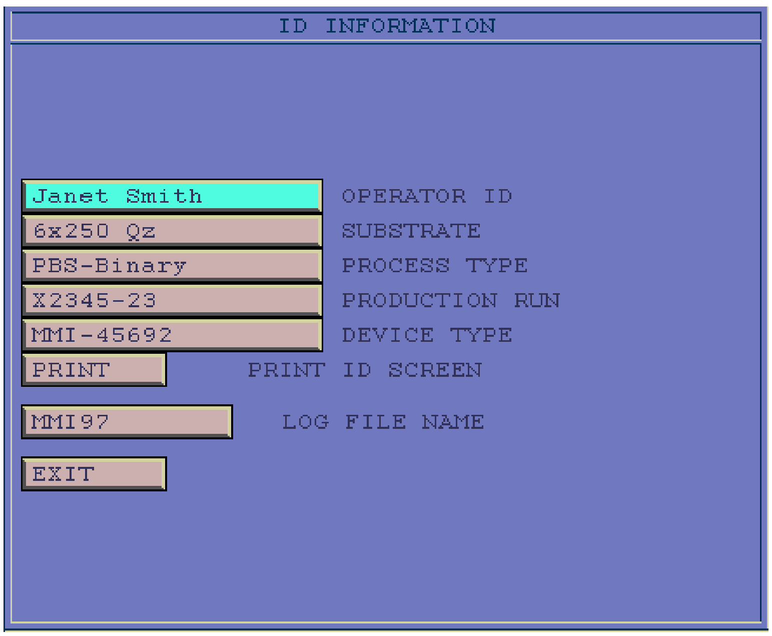
This section provides instructions for entering information about the device that you are measuring. Perform the steps in this section only if you need to change existing ID information.

To change ID entries:

1. With the Production Main Menu screen displayed, highlight the *ID Entry* button and press [SELECT].

   The ID Information screen is displayed (Figure 7-30).

Figure 7-30. ID Information Window



2. To change information displayed in a text field:
   a. Highlight the desired information.
   b. Press [SELECT].
   c. Enter new data in the text field.
   d. Press [SELECT] a second time.
3. When you are done, highlight the [EXIT] button and press [SELECT].

Clear Statistics (Optional)

If the statistics option has been set up in Supervisor mode, measurement data is automatically collected each time a measurement is made. You can use this feature to:

- view data from previous measurements
- print measurement data to a file
- discard the latest measurement statistics
- zero (clear) all measurement values

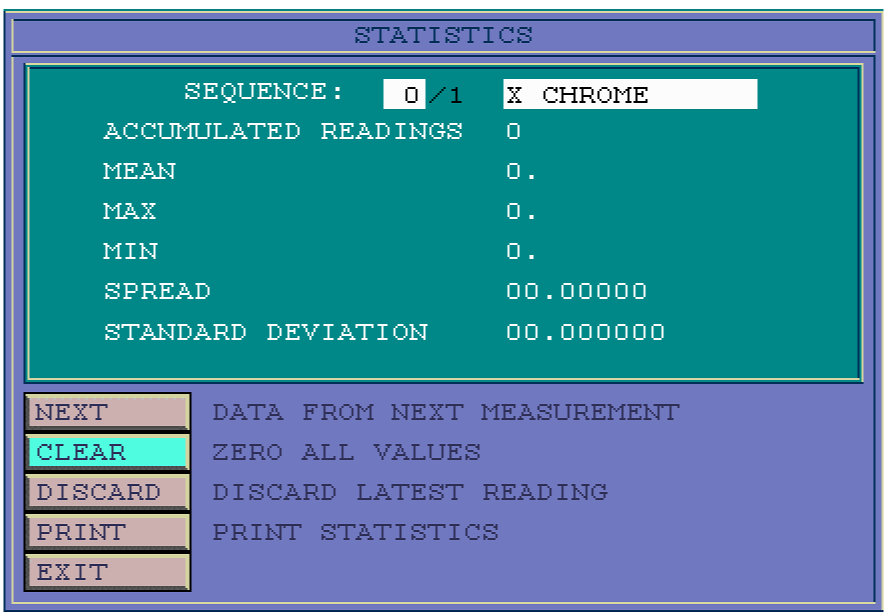
To clear statistics from a previous measurement:

1. With the Production Main Menu displayed, highlight *Stats* and press [SELECT].

   The Statistics window is displayed (Figure 7-31). This window displays the following information about the latest measurement taken:

   - sequence
   - accumulated reading
   - mean
   - maximum
   - minimum
   - spread
   - standard deviation

Figure 7-31. Statistics Window



2. To view data for the next stored measurement, highlight the [NEXT] button and press [SELECT].

Note: In order to view stored measurements, you will need to first run a script to set up this option.

---

3. To zero all values in the Statistics window, highlight the [CLEAR] button and press [SELECT].
4. To discard the latest reading stored in the Statistics window, highlight the [DISCARD] button and press [SELECT].
5. To print the displayed data to a manual LOG file, highlight the [PRINT] button and press [SELECT].
6. To close the Statistics window, highlight the [EXIT] button and press [SELECT].

Measure in Manual Mode

Note: You can perform the measurement routine in manual, semi-auto or fully automatic mode, depending on how your system is configured. Use the procedure in this section to measure in *manual* mode. If you want to perform measurements in semi-auto mode, skip this section and go on to the next section, *Measure in Semi-Auto Mode.* If you want to measure in fully automatic mode, skip this section and go on to the next section, *Measure in Auto Mode.*

The basic steps you will use to perform edge measurements in manual mode are:

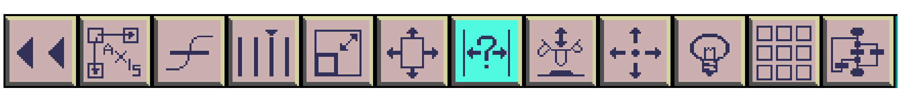
1. Locate an image.
2. Size the measurement box.
3. Position the measurement box.
4. Adjust edge selections.
5. Check illumination settings.
6. Measure feature.

Locate an Image

1. With the Production Main Menu screen displayed, highlight *MEASURE* and press [SELECT].

   The Measure menu is displayed (Figure 7-32).

Figure 7-32. Measure Menu



2. Use the → and ← turret keys to rotate the 10X objective into place.

   The objective currently in position will be displayed along the upper right portion of the screen.

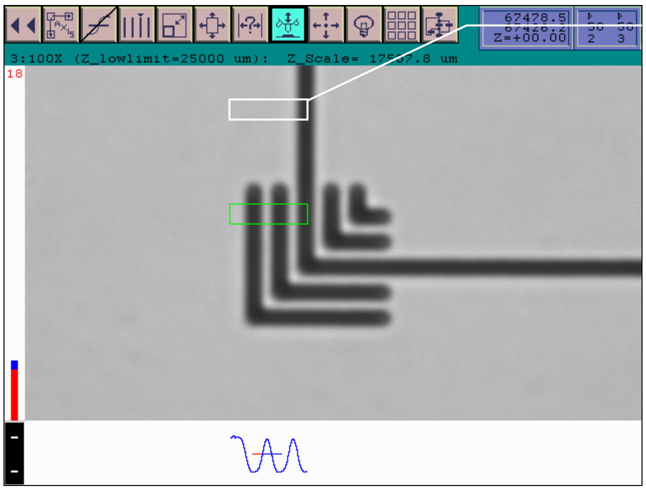
3. Use the joystick to drive the stage to a target image.
4. Use the ↑ and ↓ Focus keys to bring the image into focus.

5. Use the ➔ and 🡐 turret keys to rotate the turret to the measurement objective (normally 100X).
6. Use the focus thumbwheel to bring the image into focus.

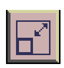
Size the Measurement Box

If the measurement box is not sized correctly (Figure 7-33):

Figure 7-33. Correct Measurement Box Size



This measurement box is sized correctly because it will easily overlap both measurement points on the feature. However, if your measurement box does not easily overlap both measurement points of your feature, you will need to resize it.

1. Highlight the  icon and press [SELECT].

   The Size dialog box is displayed.

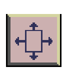
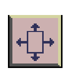
2. Resize the measurement box to correctly size the measurement box.

   When the measurement box is sized correctly, the wave at the bottom of the screen will have well-defined highs and lows (such as in Figure 5-10).

3. Once the measurement box has been correctly sized, highlight *Exit* and press [SELECT].

Position the Measurement Box

To center the measurement box over the target image:

1. Highlight the  icon and press [SELECT].
2. Use the arrow keys to position the window over the target image.
3. Press [SELECT] again to disable the  icon.

Adjust Edge Selections

The left (red) and right (blue) markers inside the measurement box should be aligned with the edges of the feature you want to measure. If you need to adjust the position of either edge, you should:

1. Highlight the  icon.
2. Press the [SELECT] key to toggle the setting displayed in the upper right portion of the screen to *Left*, *Right* or *Both.*

   Toggle to displayed window setting to *Left* if you want to move the left (red) edge marker in the measurement box.

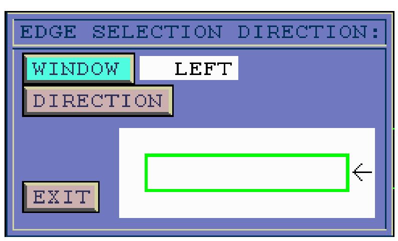
   Toggle to displayed window setting to *Right* if you want to move the right (blue) edge marker in the measurement box.

   Toggle to displayed window setting to *Both* if you want to move both the left (red) and right (blue) edge markers of the measurement box.
3. Once you have toggled to the desired direction setting, press [ESCAPE].
4. Press the ➔ and 🡐 keys to move the edge to its correct position.
5. To change the direction of the measurement scan:

   a. Highlight the  icon and press [Menu].

   The Edge Selection Direction dialog box is displayed (Figure 7-34).

Figure 7-34. Edge Selection Dialog Box



   b. Toggle the [WINDOW] button to change the axis of the scan.

   c. Toggle the [DIRECTION] button to select the direction of the scan.

   d. Highlight the [EXIT] button and press [SELECT].

Check Illumination Settings

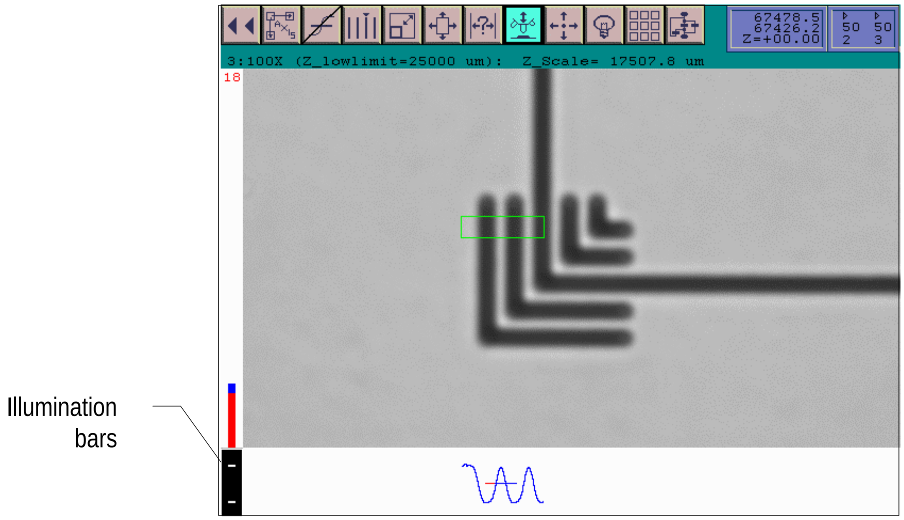
Correct illumination settings are critical to the capture of accurate measurements. This section provides a quick check to ensure that illumination settings are correct.

ⓘ **Note:** If illumination settings require adjustment, consult with an engineer before making any adjustments. Illumination settings are very involved and Zygo recommends that you not change illumination settings without first consulting an engineer.

To check illumination settings:

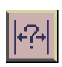
1. View the illumination bar along the lower left portion of the screen (Figure 7-35).
2. Make sure the tabs on the illumination bar are not red.
3. If the tabs are not red, proceed to the next section to measure feature edges. If the tabs along the illumination bar are red, consult with an engineer.

Figure 7-35. Correct Illumination Settings



Measure Feature Edges

To measure the edges of a feature:

1. Highlight the  icon and press [SELECT].

   The system will then perform an autofocus and measurement routine.

Measure in Semi-Auto Mode

Note: You can perform the measurement routine in manual, semi-auto or fully automatic mode, depending on how your system is configured. Use the procedure in this section to measure in *semi-auto* mode. If you want to perform measurements in manual mode, skip this section and refer to the previous section, *Measure in Manual Mode.* If you want to measure in fully automatic mode, skip this section and go on to the next section, *Measure in Auto Mode.*

The basic steps you will take to measure in semi-auto mode are:

1. Focus the system.
2. Select Go-Stop locations.
3. Measure edges.

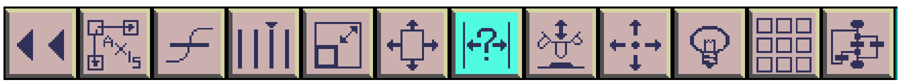
Focus the System

To focus the system:

1. With the Production Main Menu screen displayed, highlight [MEASURE] and press [SELECT].

   The Measure menu is displayed (Figure 7-36).

Figure 7-36. Measure Menu



2. Drive the stage to the origin (0,0).
3. Focus the origin:

   a. Highlight the  icon and press [SELECT].

   b. Use the ↑and ↓ keys (or the thumbwheel) to bring the location into focus.

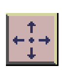
4. Auto drive to the deskew location (0,1).
5. Focus the deskew location:

   a. Highlight the  icon and press [SELECT].

   b. Use the ↑and ↓ keys (or the thumbwheel) to bring the location into focus.

Select Go-Stop Locations

To select Go-Stop locations:

1. Highlight the  icon and press [SELECT].

   The Go-Stop Location dialog box is displayed (Figure 7-37).

Figure 7-37. Go-Stop Location Dialog Box

2. Highlight the Go-Stop location number on the keypad and press [SELECT].
3. Highlight *ALIGN* and press [SELECT].
4. Highlight *SAVE* and press [SELECT]
5. Highlight *GO* and press [SELECT].
6. Drive the stage to the deskew point.
7. Highlight *SKEW* and press [SELECT].
8. Highlight S*AVE* and press [SELECT].
9. Move to each consecutive Go-Stop location and save the coordinates by highlighting *SAVE* and pressing [SELECT].

Measure Edges

To measure edges for each Go-Stop location:

1. If you want to recall a specific measurement box for the current Go-Stop location:

   a. Highlight the  icon and press [SELECT].

   The Recall dialog box is displayed (Figuree 7-38).

Figure 7-38. Recall Dialog Box

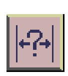
   b. Highlight the recall number on the keypad and press [SELECT].

   c. Highlight *RECALL* and press [SELECT].

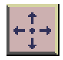
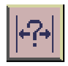
   d. Press [ESCAPE] to close the window.

   The previously saved measurement box you selected is then displayed automatically.

Note: You can use the Recall dialog box at any time to display a previously saved measurement box.

2. Highlight the  icon and press [SELECT].

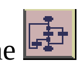
   The system will then perform an autofocus and measurement routine at the selected Go-Stop location.

3. Highlight the  icon and press [SELECT] to redisplay the Go-Stop Location dialog box.
4. Highlight *GO* and press [SELECT].
5. Press [ESCAPE].
6. Highlight the  icon and press [SELECT] to measure the new location.
7. Repeat steps 3-6 for each Go-Stop location.

Measure (auto mode)

Note: You can perform the measurement routine in manual, semi-auto or fully automatic mode, depending on how your system is configured. Use the procedure in this section to measure in auto mode. If you want to perform measurements in manual mode, skip this section and refer to the previous section, *Measure in Manual Mode.* If you want to measure in semi-automatic mode, skip this section and refer to the previous section, *Measure in Semi-Auto Mode.*

To perform measurements in auto mode:

1. With the Measurement menu displayed, highlight the  icon and press [SELECT].

   The Script File Name? dialog box is displayed (Figure 7-39)

Figure 7-39. Script File Name? Dialog Box

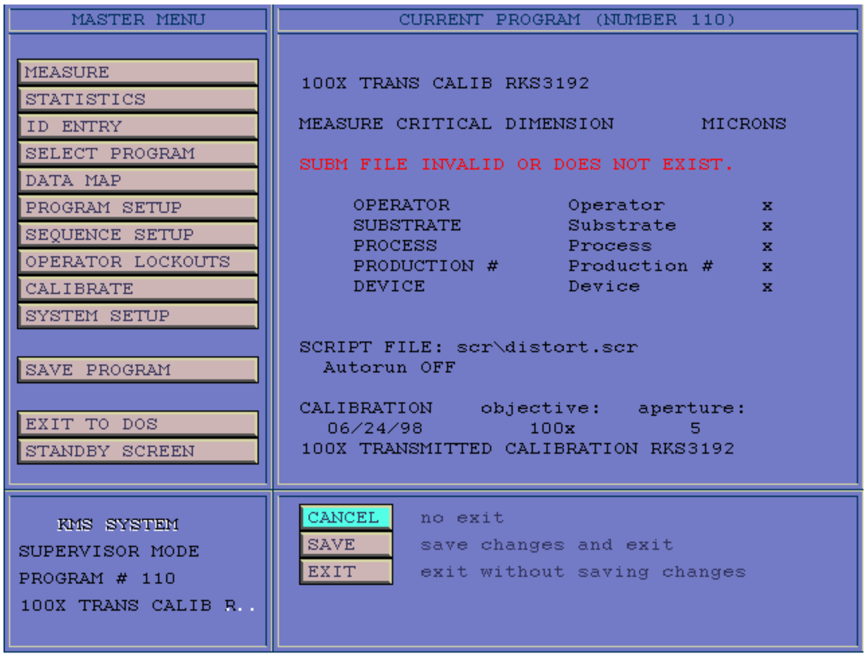
2. Enter the script name you want to run.
3. Press [SELECT].
4. Follow the screen prompts to perform an automatic measurement.

Manage Measurement Data

In this section, procedures are provided for the options on the Supervisor Master Menu screen (Figure 7-40) that are not used for program setup. These options are:

- Statistics
- ID Entry
- Data Map

Figure 7-40. Supervisor Master Menu Screen



Manage Statistics

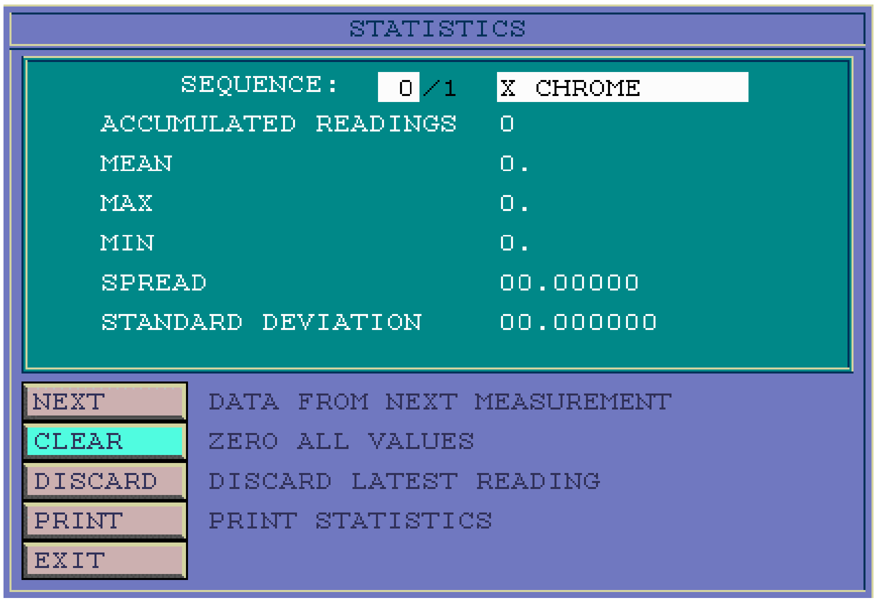
As a program is set up and saved, measurement data is automatically collected each time a measurement is made. The Statistics option allows you to use this built-in feature of the system.

To view Statistics:

1. From the Master Menu screen, highlight the *Statistics* icon and press [SELECT].

   The Statistics window (Figure 7-41) is displayed showing the accumulated readings and their values.

Figure 7-41. Statistics Screen



2. To view data from the next measurement, select *Next*. This function occurs only if a sequence of measurements is made within a script or one of the system-automated cycles.
3. To zero the values of all readings taken, select *Clear*.
4. To remove from the statistics calculations the last reading taken, select *Discard*.

   If the Log file name is incorrect, an error message is displayed.
5. To send all statistics data to the hard disk, a printer or host computer (depending on how you set up the system in Supervisor Mode), select *Print*.
6. To return to the Supervisor Master Menu screen select *Exit*, or select [ESC] at anytime.

Manage ID Entries

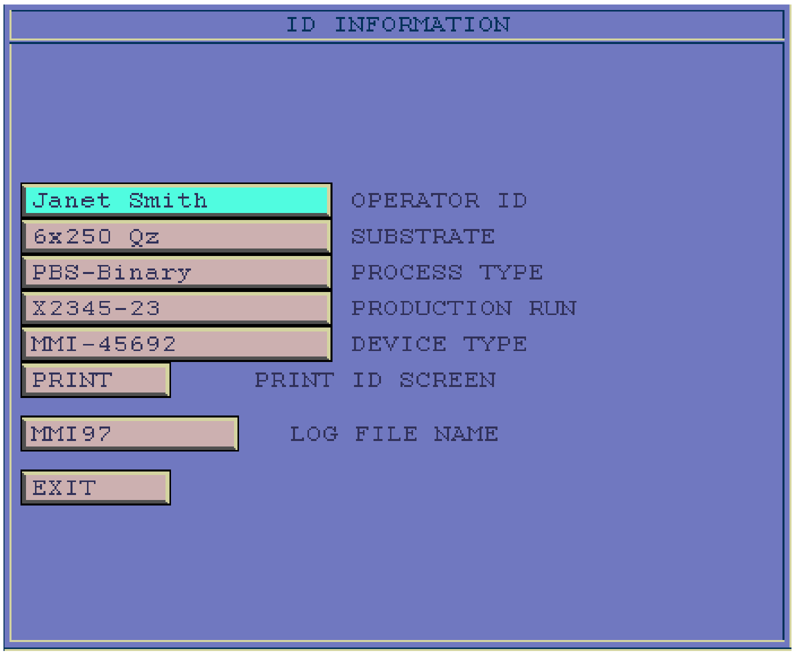
Use the ID Information screen to enter your name (or a number for production-tracking purposes), information regarding the device you are measuring, or other device identification data.

To enter information into the ID Entry screen:

1. From the Master Menu screen, highlight the *ID Information* button and press [SELECT].

   The ID Information screen (Figure 7-42) is displayed.

Figure 7-42. ID Information Screen



2. To change the displayed operator ID, type a new name in the *Operator ID* field and press [SELECT].
3. To change the displayed substrate information, type a new name in the *Substrate* field and press [SELECT].
4. To change the displayed process type, type a new name in the *Process Type* field and press [SELECT].
5. To change the displayed production run information, type a new name in the *Production Run* field and press [SELECT].
6. To change the displayed device type, type a name in the *Device Type* field and press [SELECT].

7. Select *Print* to print the ID information screen to the hard disk.

   You must specify the `logfile.xxx` name in the *Current LOG File* field (where xxx = this or script-selected program number).

   If the Log file name is incorrect, an error message is displayed.

8. To return to the Supervisor Master Menu screen select *Exit*, or you can select [ESC] at anytime.

Configure a Data Map

The Data Map dialog box is used to display measurement data in graphical form. Once the data is displayed, you may also edit individual values within the display.

The data map function is available with KMS systems only. Also, the data map function can only be used once X/Y matrix-formatted measurements are complete.

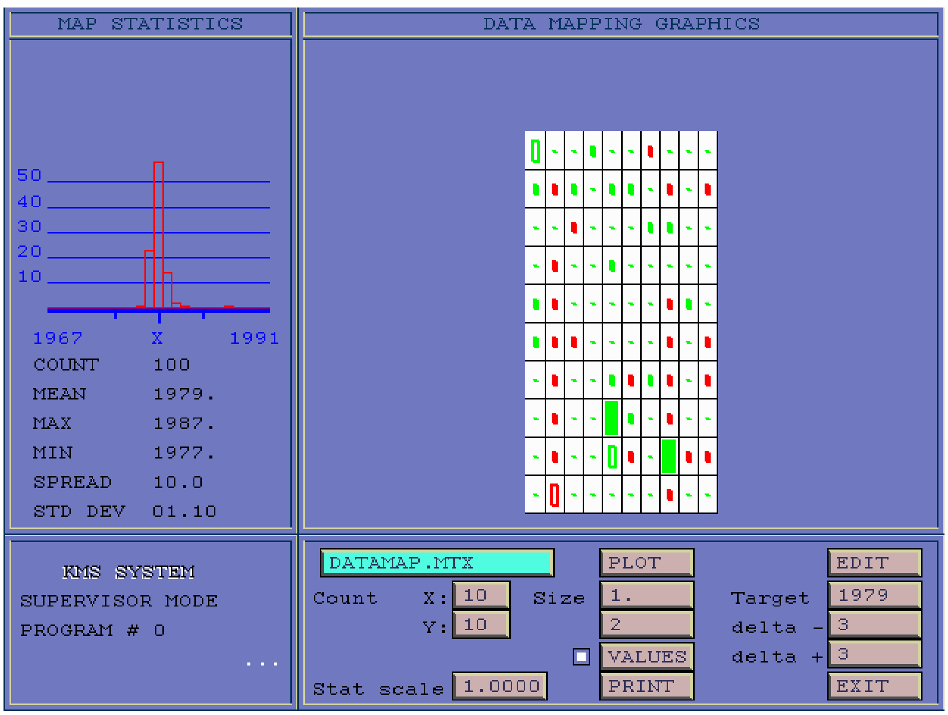
To display the Data Map screen:

1. From the Master Menu screen, highlight the *Data Map* button and press [SELECT].

   The Data Map Screen is displayed (Figure 7-43).

2. To change the displayed file name, type a new name in the highlighted field and press [SELECT].

Figure 7-43. Data Map Screen

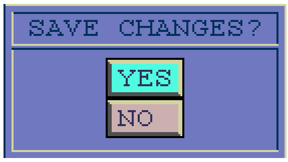


3. To set the count of the X- and Y-axis for the graph, type in new X and Y values in the *Count* fields and press [SELECT].
4. To set the values in the graph, highlight *Plot* and press [SELECT].
5. To change the displayed statistics scale, type a new value in the *Stat scale* field and press [SELECT].
6. To set the size of the graph, type in new X and Y size values in the *Size* fields and press [SELECT].
7. To set the values in the graph, highlight *Plot* and press [SELECT].
8. To set the values of the graph, select *Values* and toggle on.
9. To make changes to individual values in the graph:
    a. Select *Edit* and press [SELECT].
    b. Use the arrow keys to move around the graph and highlight a section you want to edit.
    c. Once you have selected a section to edit, press [SELECT]. The Edit Value Subscreen is displayed (Figure 7-44).

Figure 7-44. Edit Value Subscreen

    d. Enter changes in the Edit Value subscreen and press [SELECT] to return to the data mapping graphic.
    e. When prompted, confirm your changes in the Save Changes subscreen (Figure 7-45).

Figure 7-45. Save Changes Subscreen

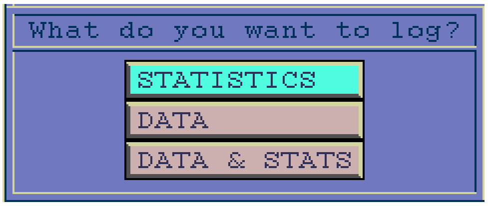


10. To set the target number, select *Target* and press [SELECT].
11. To set the delta values highlight the *delta* fields, type in a new value and press [SELECT].
12. To print the data mapping graphics screen to the hard disk, select *Print.*

    You must specify the `logfile.xxx` name in the *Current LOG File* field. If the log file name is incorrect, an error message is displayed.

13. Highlight *Statistics*, *Data* or *Data and Stats* when prompted (Figure 7-46) and press [SELECT]

Figure 7-46. What do you want to Log Message



14. To return to the Supervisor Master Menu screen select *Exit*, or you can select [ESC] at anytime.
15. Highlight *Save* and press [Select] when prompted by the system.

    The system will return to the Supervisor Master Menu screen with the Measure button highlighted.

8 Maintenance

Overview

This chapter provides a blank Preventive Maintenance Schedule to be used in planning and tracking periodic preventive maintenance of the KMS-310/400 system, as well as step-by-step procedures for each recommended maintenance activity.

This section provides a blank Preventive Maintenance Schedule, and lists maintenance procedures provided in subsequent sections of this chapter.

Preventive Maintenance Schedule

A *Preventive Maintenance Schedule* form is provided in Figure 8-1. Use this form to plan, record and monitor preventative maintenance activities for the KMS-310/400.

Table 8-1. Preventive Maintenance Schedule (1 of 2)

Interval	Procedure	Date and Initials						
Daily	Ensure that the system is floating free on the antivibration table.							
	Visually check lamp alignment and ensure that the lamp is free of flicker.							
Weekly	Ensure proper operation of turret for centration.							
	Ensure proper operation of column for parfocality.							
	Ensure that lamp is adjusted for proper uniformity and centering.							
	Ensure the microscope optics are free of dust and dirt; then clean as required.							
	Check Xenon or Mercury lamp.							
	Check calibration of the system to standard.							
	Perform system diagnostics.							

Table 8-1. Preventive Maintenance Schedule (2 of 2)

Interval	Procedure	Date and Initials						
1,500 Hours	Clean or replace air filters as needed.							
	Lubricate Z-axis lead screw, and check that lower gears are properly greased.							
	Clean, inspect, and lubricate stage lead screws.							
	Check all fans to ensure that they are working properly.							
	Check Piezo for linearity and tilt.							
	Check column backlash and torque uniformity.							
	Verify functioning of linear scales.							
5,000 Hours	Check condition of lead screws and stage motor couplings and service as needed.							
	Lubricate the column lead screw.							
	Check slip clutch and torque set screws to specifications.							
	Perform stage repeatability check.							
9,000 Hours	Remove the K2IND motor and return to factory for adjustment, cleaning, and parts lubrication.							
15,000 Hours	Have factory representative replace lead screws and align stage.							

Maintenance Procedures Overview

Maintenance procedures provided in subsequent sections of this chapter are listed in Table 8-2.

Table 8-2. Maintenance Procedures Locator

Type of Maintenance	Maintenance Procedure	Location
Lamp replacement and alignment	Visually check the lamps.	page 8-5
	Align the transmitted condenser.	page 8-5
	Replace the transmitted quartz halogen lamp.	page 8-7
	Replace the transmitted metal halide lamp.	page 8-9
	Replace and align the confocal KLH-1 lamphouse.	page 8-11
	Replace and align the confocal Nikon HMX 3/4 lamphouse.	page 8-15
Stage maintenance	Level the floating table.	page 8-20
	Level the Piezo fine focus.	page 8-21
	Adjust the mask holder guide rails.	page 8-22
	Set the column stops.	page 8-23
Electronics cabinet maintenance	Check the air filters.	page 8-25
	Check the fans.	page 8-26
System cleaning	Wipe down the system.	page 8-27
	Clean the ocular eyepieces and condenser.	page 8-27

Lamp Replacement and Alignment

This section provides instructions for each of the following lamp replacement and alignment procedures:

- Visually check lamps.
- Align the transmitted condenser.
- Replace and align the transmitted quartz halogen lamp.
- Replace and align the transmitted metal halide lamp.
- Replace and align the confocal KLH-1 lamphouse.
- Replace and align the confocal Nikon HMX 3/4 lamphouse.

Visually Check Lamps

Lamps are normally replaceD according to the manufacturer's recommendations. Xenon bulbs should be replaced every 400 hours and Mercury bulbs every 200 hours.

However, lamps can become faulty prior to the recommended number of hours. You should check lamps periodically for correct operation. You will need to replace lamps when they:

- flicker (dip while you are in focus)
- will not turn on (fire up)
- are dim
- do not maintain adequate intensity when you are viewing a substrate

When lamps need to be replaced, refer to subsequent procedures in this section for lamp replacement and alignment instructions.

Align the Transmitted Condenser

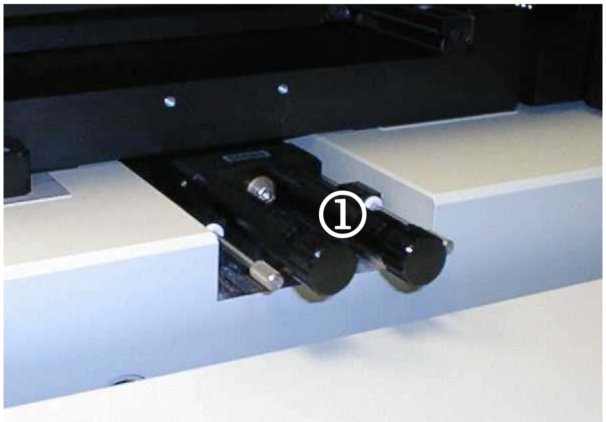
Note: Perform this procedure only when changing mask thicknesses.

To visually set up the transmitted condenser through oculars:

1. Place the photomask on the stage with the chrome side up.
2. Focus the system on an edge of a chrome feature.
3. Move the chrome edge to the edge of the oculars.
4. Set the illumination to minimize eye stress.

5. Turn the front knob on the transmitted light assembly to its mechanical stop (Figure 8-1).

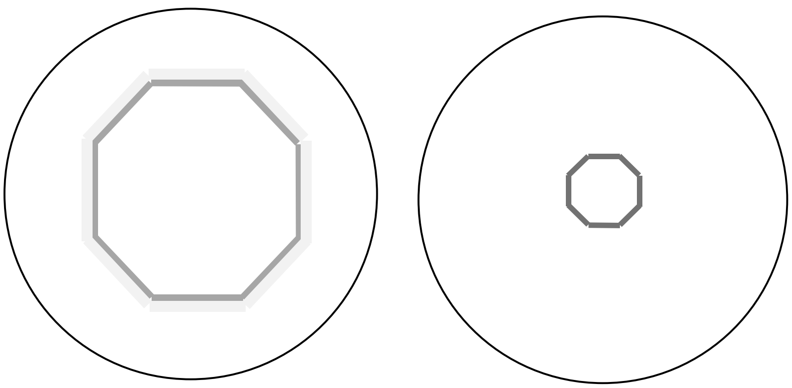
Figure 8-1. Transmitted Light Assembly Knobs



① transmitted light assembly knob

6. Close down the aperture so it is completely visible in the oculars at 10X (Figure 8-2).

Figure 8-2. Aperture in Ocular View and Focus.



Aperature partially closed while viewing in the oculars. Image of aperture is out of focus.

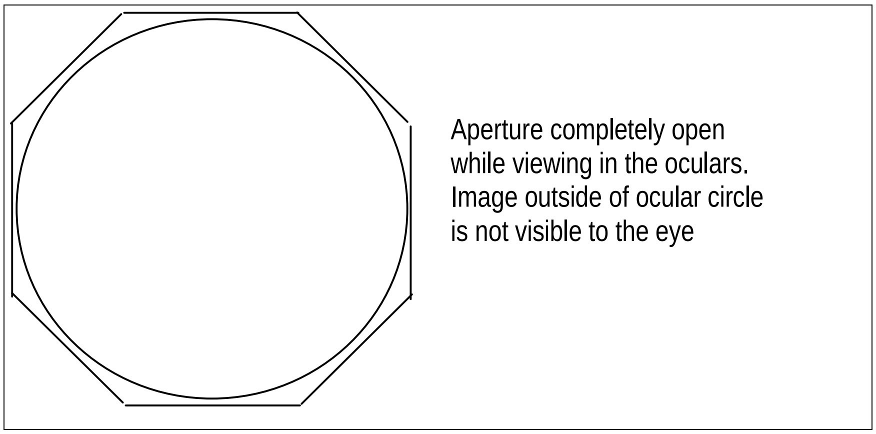
Aperture completely closed while viewing in the oculars. Image of aperture is in focus.

7. Turn the rear knob on the transmitted light assembly to bring the image into focus (Figure 8-3).

   The best focus is found when neither blue nor red flare is visible.

8. Turn the knob on the transmitted assembly at 10X until the object is slightly over-filled (Figure 8-3).

Figure 8-3. Aperture Open to Over-fill



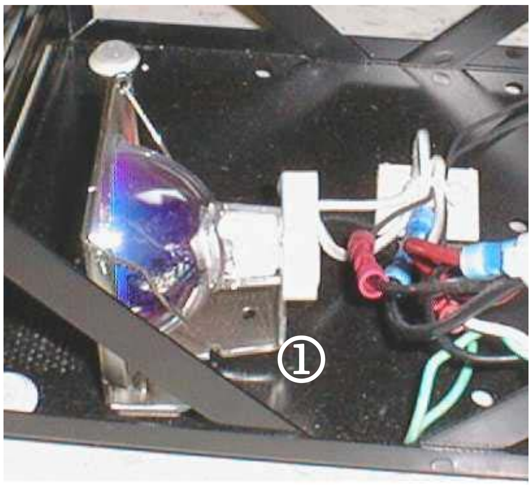
9. Set the illumination at 50X and 100X.

Replace the Transmitted Quartz Halogen Lamp

To replace the transmitted quartz halogen lamp:

1. Loosen the latch screw at the top of the lamp housing.
2. Lift the lid up and back to expose the interior of the lamp housing.
3. Slip the lamp up and out of the lamp mount (Figure 8-4).

Figure 8-4. Quartz Halogen Lamp Mount



① lamp mount

4. Unplug the lamp and remove it.
5. Plug the new lamp in and slip it down into the lamp mount.
6. Close the lamp housing lid and retighten the latch screw.

Replace the Transmitted Metal Halide Lamp

To replace and align the transmitted metal halide lamp:

1. Loosen the knurled knob at the rear of the lamp housing (Figure 8-5).

Figure 8-5. Metal Halide Lamp Housing (Rear)

① knurled knob

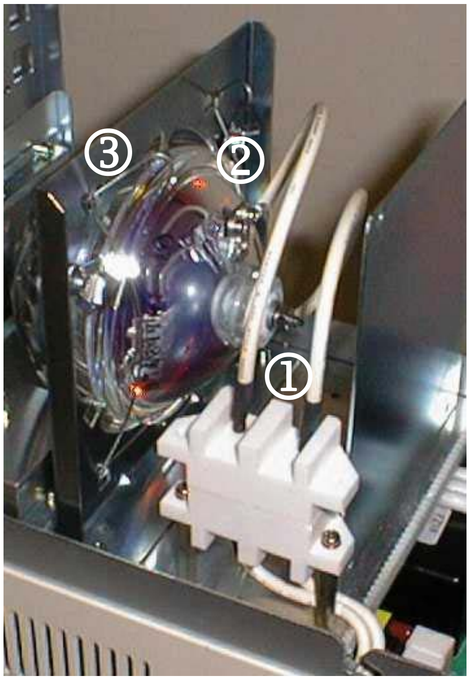
2. Slide the lid forward slightly and lift straight up and off of the housing.

Caution: To avoid damage to the lamp, always wear gloves when removing or installing lamps. If you touch the glass surface with your bare hands, clean the lamp with alcohol and a clean cloth.

---

3. Unplug the lamp connector (Figure 8-6).

Figure 86. Metal Halide Lamp Housing (Interior)



① lamp connector
② wing nuts
③ spring clips

4. Loosen the two wing nuts holding the lamp in place.
5. Unfasten the two spring clips holding the lamp in place.
6. Remove the lamp from the lamp housing.
7. Install the new lamp.
8. Attach the lamp to the lamp fixture with the two spring clips.
9. Fasten the lamp in place with the two wing nuts.
10. Plug in the lamp to the lamp connector.
11. Reinstall the lamp housing lid.
12. Retighten the knurled knob at the rear of the lamp housing.

Replace and Align the Confocal KLH-1 Lamphouse

Note: Confocal KLH-1 lamps are used by the KMS-400 only. This procedure assumes that the KLH-1 lamp is connected to the electronics cabinet with a fiber optic cable.

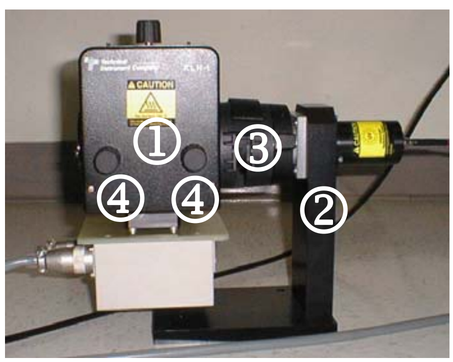
This section provides a procedure for installing and aligning the confocal KLH-1 lamp.

Replace the Confocal KLH-1 Lamp Housing Bulb

To replace the confocal KLH-1 lamp:

1. Power down the system and leave it off for 10 minutes to cool.
2. Remove the lamp housing unit from its stand by turning the housing release knob counterclockwise and pulling back on the lamp housing unit (Figure 8-7).

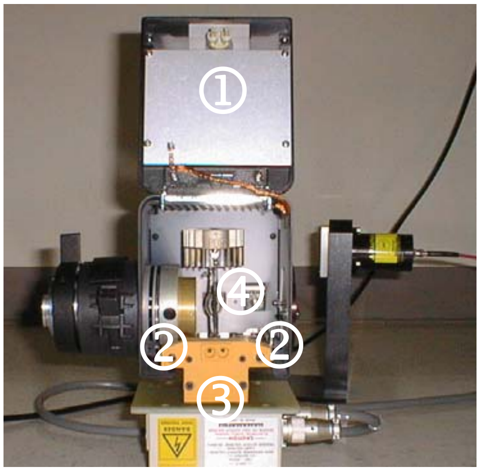
Figure 8-7. KLH-1 Lamp Housing Unit



① Lamp housing unit
② Lamp housing stand
③ Housing release knob
④ Lamp housing screws

3. Remove the two lamp housing screws and swing the lamp housing cover up and out of the way (Figure 8-8).

Figure 8-8. KLH-1 Lamp Housing Interior



① Lamp housing cover
② Lamp socket screws
③ Lamp socket housing
④ KLH-1 lamp bulb

Caution: To avoid damage to the lamp, always wear gloves when removing or installing lamps. If you touch the glass surface with your bare hands, clean the lamp with alcohol and a clean cloth.

---

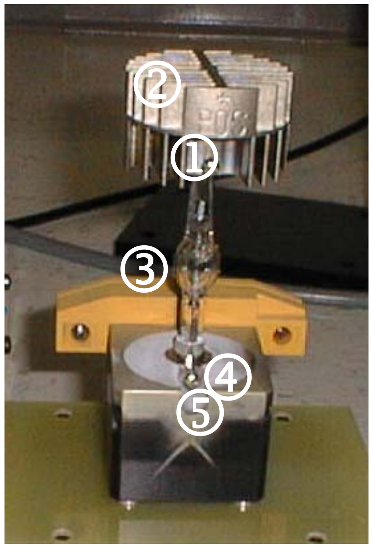
4. Unscrew the two lamp socket screws at the base of the lamp socket housing.
5. Slide the lamp socket housing (with the bulb still intact) from the lamp housing box.

Caution: The bulb and lamp socket are fragile. Do not strain the glass seal when removing the bulb from the lamp socket.

---

6. Loosen the bottom screw, then lift the heat distributor sink and bulb straight up and out of the lamp socket (Figure 8-9).

Figure 8-9. KLH Bulb



① Bottom screw
② Heat distributor sink
③ KLH-1 lamp bulb
④ Lamp socket
⑤ Heat sink screw

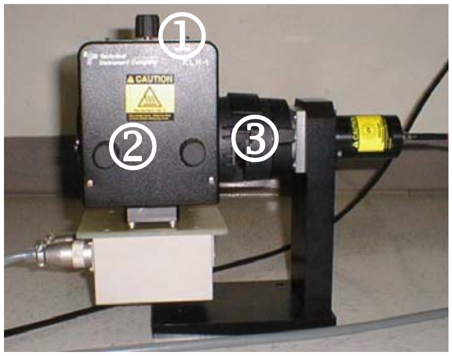
7. Set the heat distributor sink down (with the bulb pointing up).
8. Loosen the heat sink screw and gently pull the bulb out.
9. Place the new bulb into the socket with the positive side pointing up.
10. Slide the bulb along the grooves until the bulb nipple is out of the field of view.
11. Tighten down the heat sink screw.
12. Reinsert the heat distributor sink/bulb assembly back into the lamp socket housing.
13. Close the lamp housing cover and retighten the two housing screws.
14. Put the lamp housing back on the stand and rotate it clockwise on the lamp housing stand until tight.

Note: The lamp is keyed so that the bottom is larger than the top. When reinstalling the lamp housing back onto the stand, make sure the lamp wire is turned to the side.

Align the Confocal KLH-1 Lamphouse

To align the confocal KLH-1 lamphouse (Figure 8-10):

Figure 8-10. KLH-1 Lamphouse Adjustment Knobs



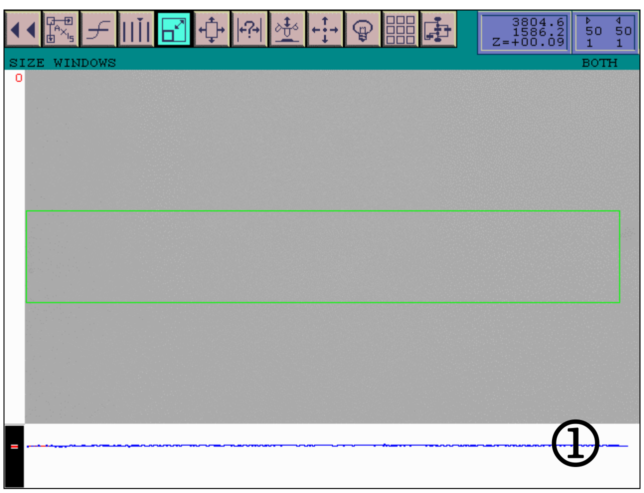
① Vertical lamp adjustment knob

② Horizontal lamp adjustment knob

③ Lamp condenser adjustment knob

1. Use the horizontal lamp knob on the lamphouse to bring the scan line just into view at the bottom of the screen.
2. Use the vertical lamp knob on the lamphouse to flatten the scan line.
3. Move back and forth between the horizontal and vertical lamp knobs to achieve a flat scan line (Figure 8-11).

Figure 8-11. Flat Scan Line



① scan line

Replace and Align the Confocal Nikon HMX 3/4 Lamphouse

Note: Confocal Nikon HMX 3/4 lamps are used by the KMS-310 only. This procedure assumes that the Nikon HMX 3/4 lamp is mounted on a K2 module with a phase telescope installed on the ocular lenses.

This section provides a procedure for installing and aligning the confocal Nikon HMX 3/4.

Replace the Nikon HMX 3/4 Lamp

To replace the Nikon HMX 3/4 lamp:

1. Power down the system and leave it off for 10 minutes to cool.
2. Loosen the lamp housing screw of the Nikon HMX lamp housing (Figure 8-12).

Figure 8-12. Nikon HMX Lamp Housing

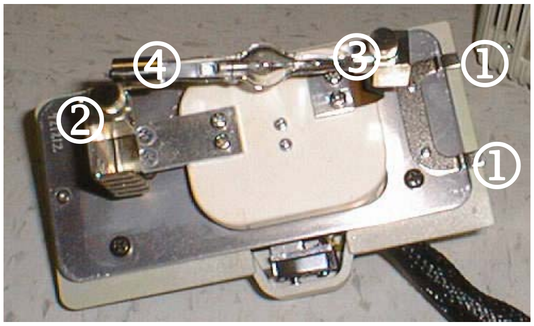
① Lamp housing
② Lamp housing screw
③ Lamp housing door

3. Swing the lamp housing door down, making sure the door hinges remain in place.

Caution: To avoid damage to the lamp, always wear gloves when removing or installing lamps. If you touch the glass surface with your bare hands, clean the lamp with alcohol and a clean cloth.

4. With the interior of the lamp housing door exposed, loosen the fixed clamp knob (Figure 8-13).

Figure 8-13. Nikon HMX 4 Lamp Housing Door and Bulb



① Housing door hinges
② Fixed clamp knob
③ Flexible clamp knob
④ Bulb tip

5. Loosen the flexible clamp knob.
6. Hold the bulb tips and pull the bulb straight out of the lamp housing door.
7. Insert a new bulb into the flexible clamp of the lamp housing door with the wire facing in.
8. Tighten the flexible clamp knob.
9. Insert the bulb completely into the seat of the fixed clamp.
10. Tighten the fixed clamp knob.

Caution: The bulb and lamp socket are fragile. Do not strain the glass seal when removing the bulb from the lamp socket. Do not put side pressure on the bulb and do not touch the lamp element

11. Make sure each end of the bulb is securely seated in its socket.
12. After changing the bulb, turn the power on.
13. Wait approximately five minutes for the arc lamp (Mercury or Xenon bulb) to warm up and stabilize before aligning the lamp.

Align the Confocal Nikon HMX 3/4 Lamphouse

The lamp and the condenser create the primary image. The direction of the primary image is controlled by the knobs, which are attached directly to the lamp mounting mechanism. If your substrate requires additional light, your lamp housing may include an additional mirror at the rear of the housing. This mirror produces a secondary (reflected) image due to this spherical mirror intersecting the reflected image of the lamp electrodes.

To align the lamphouse:

1. If you are working with a Nikon Model 4 (with reflecting rear spherical mirror), turn one of the mirror adjustment knobs to move the mirror out of view (Figure 8-14).

Figure 8-14. Nikon HMX 4 Lamp Adjustment

① Mirror adjustment knobs

② Primary Condensor Knob

③ Vertical adjustment knob

④ Horizontal adjustment knob

2. Use horizontal, vertical and condenser knobs to center the primary lamp's cathode and diode in the field of view.
3. Power up the lamp.
4. Remove one of the eyepieces and replace it with the phase telescope.
5. Position the aperture diaphragm at position 1.

6. Focus the phase telescope on the blades of the aperture diaphragm.

Note: Do not change the focus for the phase telescope once it has been set. If you use the phase telescope for this microscope only, it will not be necessary to refocus once you remove it.

---

7. Use the primary condenser and vertical/horizontal adjustment knobs to focus and center the primary light source.
8. If you are aligning a Nikon Model 4 (with rear mirror assembly), use the mirror adjustment knobs to focus and center the secondary light source in the field of view.
9. Load a substrate onto the stage.
10. Focus on an object first at 10X, then at 100X.
11. Use the primary condenser knob to contract the arc uniformly in all directions. (If you turn the knob in the wrong direction, the image will go out of focus.)

Note: The direction of rotation can change, depending on where the eccentric drive pin is located with respect to the condenser.

---

12. If the illumination does not contract uniformly from all directions, move the lamp's horizontal and vertical knobs to position the light source so that you can contract the light source evenly out of the field of view.

    When the dark borders of the evenly expanded lamp arc are expanded slightly out of the field of view, the primary beam is properly aligned.

Stage Maintenance

This section provides instructions for each of the following stage maintenance procedures:

- Level the floating table
- Level the Piezo fine focus
- Adjust the mask holder guide rails
- Set the column stops

Level the Floating Table

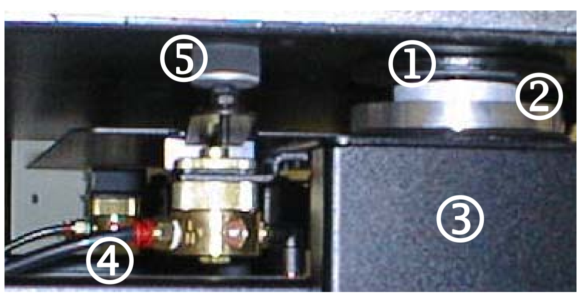
To make sure the floating antivibration table is working correctly, you will need to make sure all four corners can be moved up or down without restriction. If any of the corners cannot be moved without restrictions, you will need to adjust the leveling screws.

This section provides instructions for checking table flotation and making necessary adjustments.

Check Table Floatation

To check flotation of the antivibration table (Figure 8-15):

Figure 8-15. Antivibration Table Flotation



① Corner tabs
② Metal collar
③ Table leg
④ Cables
⑤ Lever knob

1. Make sure each lever arm is approximately horizontal and is not touching any part of the table.
2. Make sure the four corner tabs are floating 1/4 to 3/8 in. between the top and bottom of the table.
3. Make sure the metal collar sits above the table leg by 1/4 to 3/8 in.
4. Make sure all system cables are suspended from the wall or ceiling by a flexible strap.

   Vibration can be induced when if the cables touch the wall, or if they are moved.

Adjust Table Flotation

To adjust table flotation:

1. To adjust the flotation and height of the table, use the three red lever knobs to raise or lower the height of the three table corners.
2. Recheck the position of the table and each corner to ensure they are horizontal.

Level the Piezo Fine Focus

To level the Piezo fine focus:

1. Load a photo mask onto the stage (preferably a 6 in. mask).
2. Drive the stage to the front so that the turret is located at the center back of the mask.
3. Use an image at the back center of the mask to center the stage.
4. Focus on an image at 10X.
5. Drive the stage to the front right corner of the mask.
6. Locate and focus on an image at 10X.
7. Adjust the right front screw on the Piezo to bring the image into focus on the monitor.
8. Drive the stage to the front left corner of the mask.
9. Locate and focus on an image at 10X.
10. Adjust the front left screw on the Piezo to bring the image into focus on the monitor.
11. Repeat steps 2-10 at 50X.
12. Repeat steps 2-10 at 100X.

Adjust the Mask Holder Guide Rails

Correctly adjusted mask holder guide rails can minimize deskew correction.

Before starting this procedure, you will need to have:

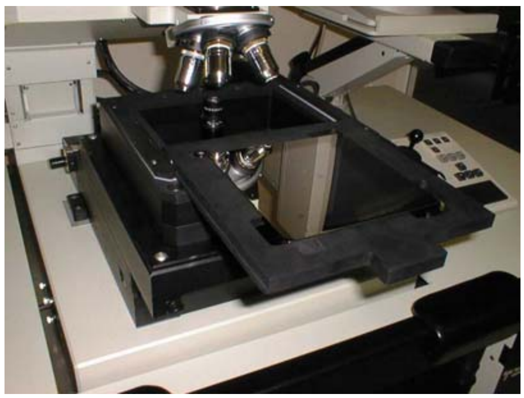
- an etched mask with identical targets spaced horizontally and vertically across the entire mask surface
- a script similar to CNTRWIND.SCR that can place a large split cross to define the center of the monitor

Caution: This procedure will affect any saved matrix values for scripts such as ALIGN, DESKEW, or ORIGIN.

To adjust the mask holder guide rails:

1. Place the mask against the right front corner of the mask holder. (Figure 8-16)

Figure 8-16. Mask Holder Guide Rails



2. Tighten the front hold-down screw on the rigid guide rail. The screw should be tight enough so that the guide rail stays in position, yet loose enough so that the rear portion of the guide rail can be rotated.
3. Loosely tighten the rear hold-down screw on the rigid guide rail.
4. Insert but do not tighten the hold-down screws on the opposite (spring loading) guide rail.
5. Place the mask holder at the back of and between the guide rails.
6. Apply even pressure against the left side of the mask holder and drive the stage to the right-front corner of the mask.
7. Locate a target with the 10X objective.
8. Drive the stage to the front of the system. Observe the rotation direction of row images as the stage moves from back to front.
9. Move the rear of the rigid guide rail to correct mask rotation during stage travel.
10. Align the rear target by tapping the guide rail in either direction.
11. Repeat steps 6-10 at 50X and 100X.
12. Once the stage has been aligned to within 5-10 microns back to front, tighten the two hold-down screws on the left guide rail.

13. Test the alignment by removing and replacing the mask into the holder, replacing the mask holder onto the stage, then find the same targets and test alignment.

Tip: Use Go-Stops to store at least the two front and rear locations. This will make it much easier to remove and replace the mask for checking repeatability because the same locations used to check alignment will be much easier to find.

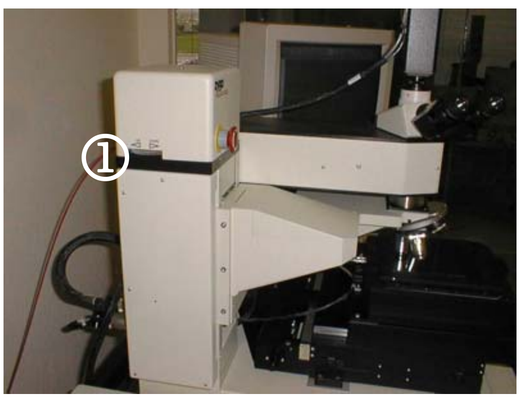
Set the Column Stops

Margin of safety is approximately 50-100 microns.

To set column stops:

1. From the Measure screen, select the  icon and record the scale readout.
2. Turn the column limit switch (Figure 8-17) up until the red LED is lit.

Figure 8-17. Column Limit Switch and LED



① column limit switch

3. Using the keypad, slowly drive the column down approximately 180 microns.
4. Turn the column limit switch down until the red LED goes off.

Caution: Drive the colum down slowly. If you drive the column too fast, column power will be shut off by an emergency limit switch.

Electronics Cabinet Maintenance

This section provides instructions for the following electronics cabinet maintenance procedures:

- Check air filters
- Check fans

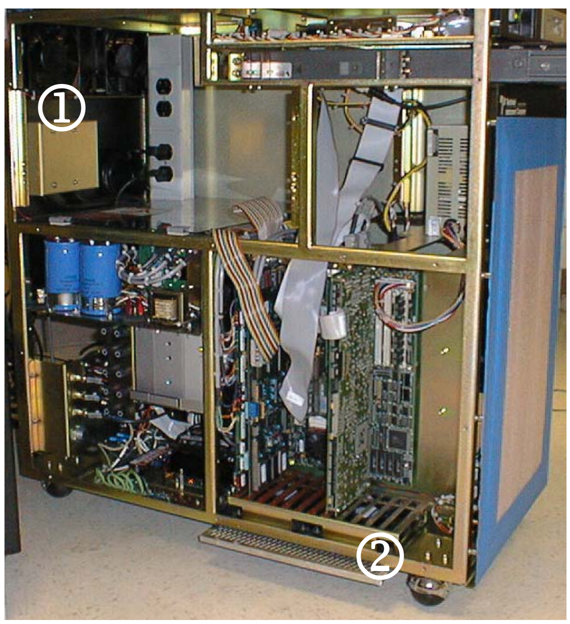
Check Air Filters

To check and replace the electronics tower air filters (Figure 8-18):

1. Roll out the electronics tower from the side of the KMS-310/400.

Caution: Make sure you do not pull any cables or wires when rolling out the electronics tower.

Figure 8-18. Electronics Tower Air Filters



① Top-rear air filter

② Bottom-front air filter

2. Remove the seven screws on the left side panel of the electronics tower, starting from the bottom.
3. Check the air filters for debris. Remove any paper, plastic, or other foreign objects.
4. Replace either of the air filters if they are dirty.
5. After you have inspected the air filters, use their guide rails to slip them back into place.

6. Use the seven screws to reinstall the electronics tower side panel.
7. Return the tower to its position on the side of the KMS-310/400.

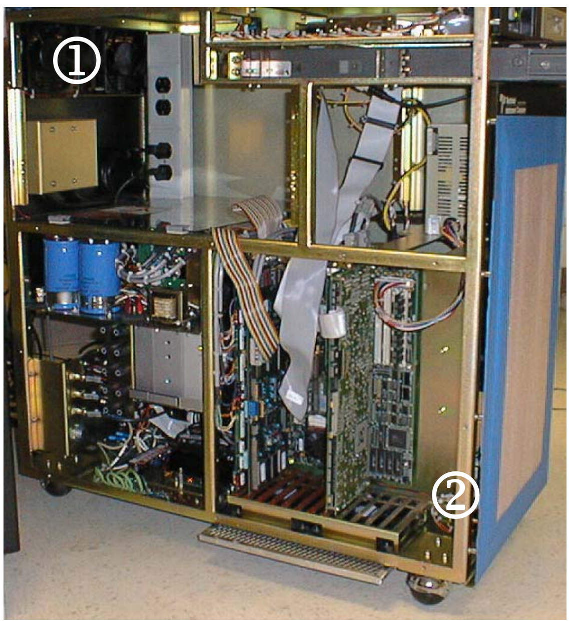
Check Fans

To check the fans (Figure 8-19):

1. Roll out the electronics tower from the side of the KMS-310/400.

Caution: Make sure you do not pull any cables or wires when rolling out the electronics tower.

Figure 8-19. Electronics Tower Fans



① Rear two fans

② Front two fans

2. Remove the seven screws on the left side panel of the electronics tower, starting from the bottom.
3. Make sure that all four fans are spinning correctly.
4. Use the seven screws to reinstall the electronics tower side panel.
5. Return the tower to its position on the side of the KMS-310/400.

System Cleaning

This section provides instructions for each of the following system cleaning procedures:

- Wipe down the system
- Clean the ocular eyepieces and condenser

Wipe Down the System

When wiping down the system, keep in mind the following guidelines:

1. Use IPA (isopropyl alcohol) and cleanroom wipes.
2. Wipe down the system from top to bottom.
3. Do not clean ocular eyepieces, objectives and objective casings, or the condenser cap with alcohol.
4. Do not move the column safety adjustment wheel when cleaning the column.

Clean the Ocular Eyepieces and Condenser

When wiping down the ocular eyepieces and condenser, keep in mind the following guidelines:

1. Use methyl alcohol or other approved optics cleaning solutions.

9 Error Messages

System Error Messages

Script Error Messages

System Error Messages

This section provides an explanation for common KMS-310/400 system error messages.

Table 9-1 lists common system error messages. For each error message, this table provides a definition and suggested course of action to correct the problem.

Table 9-1. System Error Messages

Error Message	Meaning	Corrective Action
Z-column error #6	Tried to drive Z-Column below mechanical limit switch	1. Remove the mask. 2. Power down the system. 3. Restart the system.
Z-column at upper limit	Tried to drive the objectives up and too far away from the sample	Select the *Focus* icon and drive the column back down until the message goes away.
Z-column at lower limit	Tried to drive the objectives down too close to the sample	Select the *Focus* icon and drive the column away from the sample until the message goes away.
Z-column software limit	Z software limit has been set during objective setup. The operator has attempted to drive towards the sample and past the software limit.	1. Drive the column back away from the sample. 2. If desired, reset to a larger software limit value by performing the objective setup procedure.
Illegal turret move	Virtual objective was set in the System.cfg file and the objective set up was not carried out properly.	Reset the objective setup. Take care to correctly set the relationship between the reference objective and RIC objective plane(s).
Edges not found	Edge selection for given feature is incorrect. Operator has picked the wrong edge count for a given feature.	Select the *Edges* icon, re-select the correct edges, and scan direction for the feature.
0.000 for measurement value	Measurement was taken on one edge only, or measurement was out of range for the current multi-point (sub-M) file.	1. Select the *Edges* icon, re-select the correct edges, and scan direction for the feature. 2. Check the expected feature CD value against the multi-point calibration table limits.

Script Error Messages

This section provides an explanation for common KMS-310/400 script error messages.

Table 9-2 lists common KMS-310/400 script error messages. For each error message, this table provides a definition and suggested course of action to correct the problem.

Table 9-2. Script Error Messages (part 1 of 2)

Error Message	Meaning	Corrective Action
Load Failed – RETRY (Yes/No)	Incorrect spelling or path used to run a script. INCLUDE commands are used but the files named are non-existent or are in the wrong path.	1. Check script name and/or path for correct spelling. 2. Check all INCLUDE commands in the script. Make sure that all paths and named scripts are correct. Check actual directories for “included” scripts. 3. Make sure there are no nested INCLUDE commands. A script that uses an INCLUDE command cannot include a second script that also uses INCLUDE commands.
Loadfile ### Failed	LOADCALIB: command failure. The calibration file number that is called out is nonexistent. The system will skip this command and load in the last known calibration file.	1. Make sure the calibration file and associated number have been created and are in the correct place.

Table 9-2. Script Error Messages (part 2 of 2)

Error Message	Meaning	Corrective Action
Matrixwrite Error	Syntax error in setting up the MATRIX commands. An incorrect handle may have been called for called for in a given MATRIXWRITE command, or there is no MATRIXSET command preceding the MATRIXWRITE command.	1. Check the MATRIXOPEN command for errors in the named path. (No spaces are allowed in the path.) 2. Check the MATRIXOPEN command to make sure the named handle is the same as the MATRIXWRITE command handle. 3. Make sure the MATRIXSET command has been used properly preceding the MATRIXWRITE command.
Not A Command :LLLLL	Syntax error in script code. The LLLLL command may not be a spelled correctly, or is not followed by a colon.	1. Make sure the LLLLL command is spelled correctly and is followed by a colon.
Program Does Not Exist	LOADPROG: command error. The program number called out in LOADPROG does not exist.	Add the appropriate program number (called out in LOADPROG) to the script.
Stack Overflow CALLs nested 30 deep	A CALL command has been invoked without the necessary RETURN command to follow.	Check the order of the CALL commands to see if they coincide with a RETURN command.
Stack Underflow More Returns than Calls	A RETURN command has been used without the necessary CALL command being invoked first.	Check the order of the RETURN commands to see if they coincide with the CALL commands in the script.
Value Not Found Use V00 to V99 or decimal	CALL command syntax error. Graphics command syntax error.	1. Make sure the CALL command is followed by a 0, a non-zero value or the variable V##. 2. Make sure graphics commands, such as BOX or LINE, have at least five values after the command. Values should be listed in the order of X1, Y1, X2, Y2, and color.

Glossary

align. To put into proper relative position or orientation.

anomaly (ies). An occurrence on a substrate judged to be unexpected. Something abnormal, incongruous or inconsistent. Once an anomaly is reviewed, it may be classified as a *defect*.

aperture diaphragm. An iris that controls depth of field and contrast.

binary photomask. Photomask using an opaque material (such as chrome) as the attenuator, deposited on a highly transparent material (such as quartz or fused silica).

brightness. The overall intensity level in a video image.

condenser. An optical assembly that organizes random light into a cohesive, focused beam.

contrast. The difference in intensity between (nearby) pixels in a video image.

convolution. An image processing operation used to spatially filter a video image.

deep ultra violet (DUV). Portion of the electromagnetic spectrum from approximately 200nm to 300nm. The typical value associated with this term is 248nm.

defect. 1. A physical, optical, chemical or structural irregularity that degrades the ideal *substrate* structure or the thin films built over the *substrate*. 2. An undesirable classified *anomaly*.

deskew. Software process used to remove the rotational factor from an orthogonal X and Y motion stage.

device. The end-product of a semiconductor process (e.g. DRAM, EPROM, or LOGIC).

die. 1. A *field* sub-unit 2. The area of a *substrate* that contains the *device* being manufactured.

edge detection. A method of isolating and locating an optical edge in a digital video image.

edge. Point at which the waveform crosses from dark to light with transmitted or reflected illumination.

feature. 1. A line or a point (as a feature within a pattern). 2. A physical characteristic of the substrate (e.g., a wafer flat).

field. The printed pattern from a reticle.

gray level. A shade of gray assigned to a pixel in a video image.

illumination e-line. The portion of the electromagnetic spectrum generated from the output of a mercury arc lamp. The typical value associated with this term is 533nm.

illumination g-line. The portion of the electromagnetic spectrum generated from the output of a mercury arc lamp. The typical value associated with this term is 436nm.

illumination, i-line. The portion of the electromagnetic spectrum generated from the output of a mercury arc lamp. The typical value associated with this term is 365nm.

index of refraction. Expressed in the formula (n=C/V), where C is the speed of light and V is the speed of light in a given material. Material such as quartz, with low (n) values, will deflect light rays to a lesser extent than material with higher (n) values.

Koehler illumination. A specific illumination technique that provides a uniformly illuminated image field from a non-uniform light source.

layer. The deposition of a certain material on a wafer for the purpose of producing a semiconductor *device*. Many different layers are generally required to produce a device. Several *process steps* may be used to create each layer.

linewidth. For a given cross section of a line, such as chrome on quartz, the calculated distance between specified thresholds.

lot. A group of one or more *substrates* of the same type (e.g., wafers, masks, CDs, etc.).

median filter. An image spatial filtering operation based on an input pixel and its eight neighbors.

metrology equipment. Any equipment that collects and reports information on specific predetermined locations (or *features)* on a *substrate* with consistent data structure, or reports general information about the entire *substrate*.

micron (micrometer). Metric unit of measure that is equal to 1/1,000,000 of a meter.

nanometer. Metric unit of measure that is equal to 1/1,000 of a micron or micrometer.

NIST. Acronym for the National Institutes of Tests and Standards, formerly known as the National Bureau of Standards (NBS).

objective, ELWD. Acronym for extra long working distance. An objective used to gather measurement information when the distance between the sample and the lowest point of the objective are relatively far apart.

objective, RIC. Acronym for refractive index correcting. An objective used to gather measurement information about a sample through a layer of quartz.

objective. The lens closest to the substrate that collects the reflected or transmitted light information and, when properly focused, produces the primary magnified image of the sample.

oculars. A highly corrected magnifier that transfers an image from the objective to the viewer's eyes.

origin. Referred to as the (0,0) coordinate, this location is usually at the lower-left corner of the active geometry or die.

parcentration. The ability of an imaging system to centrally locate a single point of an image in the field of view for more than one objective mounted on a single system.

parfocal. The ability of an imaging system to maintain focus when switching from one objective to another.

pellicle. A thin, optically transparent film, attached to and supported by a frame and attached to a photomask or reticle, used to seal out airborne contamination.

photomask. A combination of transparent and opaque materials, such as quartz with a layer of patterned chromium oxide. Used to transfer the circuit design to the wafer by means of an optical projection system.

pitch. A measurement dimension that utilizes similar slopes of line and space pair features to initiate the calibration of a line width measurement system.

pixel. Industry standard term for the most basic element of a digital image.

planarization. Process used to geometrically level the photomask or reticle using software. This enables the KMS system to maintain a coarse focus across much of the surface of the photomask or reticle.

process steps. 1. The individual steps required to create a complete *process* to make a semiconductor *device.* 2. The individual steps required for each *layer.*

process. The formula or recipe used to create a semiconductor *device.*

resist, electron beam (e-beam resist). Polymer material sensitive to an electron beam source that is used to expose the original image on the photomask or reticle from the design information.

resist, optical (photo-resist). Polymer material sensitive to a light source, such as a laser beam, that is used to expose the original image on the photomask or reticle from the design information.

resolution. Refers to both *spatial* and *intensity* resolution. Spatial resolution is the number of pixels per unit of length along the X- and Y-axes. Intensity resolution is the number of quantified levels that a pixel can have.

reticle. see Photomask

script. Series of commands that direct the KMS system to perform specific functions such as measuring, moving the stage, and performing pattern recognition routines.

spacewidth. For a given cross section of a space, such as the space between two chrome features on quartz, the calculated distance between specified thresholds.

substrate n. The basic unit of material processed by inspection and review equipment, such as wafers, CDs, flat panels and masks.

threshold, detection. The location on the grayscale of a material edge, such as chrome or resist, which designates the initial and final calculation points within an image identification or analysis routine.

threshold, measurement. The location on the grayscale of a material edge, such as chrome or resist, which designates the initial and final calculation points within the measurement routine.

trinoculars. A set of oculars with a third port for the attachment of a camera or other accessory.

turret. The rotational receptacle that multiple objective lenses are affixed to.

working distance. The distance from the focus point of the object plane to the front surface of the objective.

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