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# Quantox® User's Guide
# for
# Software Version 3.4.3 General Release

**KLA-Tencor Confidential**

KLA-Tencor
Film and Surface Technology Division

**CE COMPLIANCE**

At the time of this printing, the Quantox 200-mm system complies with EC Machinery Directive 89/392/EEC, EC Low Voltage Directive 72/23/EEC), and EC Electromagnetic Compatibility Directive 89/336/EEC.

In addition, the system is compliant with these standards:

Harmonized safety standards EN 61010-1:1993/A2:1995; EN60204-1: 1993; EN563: 1994;EN 418: 1992; EN292 Parts 1 and 2: 1991; and EN 60825-1: 1994.

Harmonized electromagnetic standards EN 50081-1: 1992; EN50082-2: 1995; EN55011: 1991.

The Quantox 300-mm system complies as a Noncontact Oxide Monitoring System under the following EC directives:

EC Machinery Directive 98/37/EEC; EC EMC Directive 89/336/EEC; and EC LVD Directive 73/23/EEC.

Harmonized Standards EN 292 Parts 1&2: 1991; EN 418: 1992; EN 563:1994; EN 55011: 1991; EN 60204-1: 1993; EN 50081-2: 1994; EN 50082-2: 1995; EN 61010-1: 1993/A2: 1995; EN 60825-1: 1994.

We welcome your comments about this document. Please email them to Film and Surface Technology Technical Publications or contact us at the address shown below. Please reference the document’s part number in your communications.

KLA-Tencor Corporation
Film and Surface Technology Division
160 Rio Robles
San Jose, California USA 95134
Phone: 408-875-4200 Fax: 408-571-2820
email: FaSTTechPubs@kla-tencor.com

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# *Introduction*

The Quantox System is a non-contact, corona-based silicon and oxide charge monitoring system. The underlying measurement principles are similar to those upon which MOS C-V testing is based. However, unlike C-V testing, there is no physical contact between the probe and the wafer surface, eliminating the time and expense required to form electrical contacts. The Quantox System measures electrical characteristics such as charge composition, interface quality, dielectric thickness, and charge contamination of semiconductors and dielectric films.

The Quantox system's precision process control measurements enable comprehensive gate production control and early detection of contamination and plasma damage events. Measurements can be made immediately after gate formation to determine gate dielectric quality and reliability. The Quantox system can be used to routinely monitor for metallic contamination such as Fe, Al, Cu, and Na. The system also provides a breakdown of electrical charge contamination into individual charge categories that can be used to diagnose process shifts or excursion events.

Quantox measurements are performed with an easy-to-use Windows NT™ -based software interface. A separate Offline Recipe Generator and Data Analysis package, using the same system interface, provides remote recipe generation and data analysis capabilities thus increasing tool use.

# Using This Manual

This manual supports the Quantox Oxide Charge Monitoring System. It provides the information necessary to initialize the system, create test recipes, and to collect and analyze, and manage data.

The chapter and appendixes in this manual include

| | |
|---|---|
| • Chapter 1 | Safety |
| • Chapter 2 | System Overview |
| • Chapter 3 | Quantox Recipe Builder |
| • Chapter 4 | Quantox Operator Interface |
| • Chapter 5 | Report Generator |
| • Chapter 6 | Data Wizard |
| • Chapter 7 | Database Administration |
| • Chapter 8 | Q Doctor |
| • Appendix A | Measurement Theory |
| • Appendix B | System Administration |
| • Appendix C | SECS/Gem Interface |
| • Appendix D | Glossary |

# Understanding Conventions

The following conventions are used in this manual.

- Throughout the manual, *system* refers to Quantox 200 and 300mm Systems, including both the wafer tester and wafer handler.
- Throughout the manual, *tester* refers to the system's tester.
- The term *process operator* is used to describe a person in the wafer fabrication area who operates the system, while the term *process engineer* is used to describe a person who sets up tests on the system. We recognize that in some instances, these delineations may vary.
- Keyboard keys are shown with an initial capital letter. For example: After keying in your response, press Enter.
- Key combinations and sequences are described as follows:
  - "Press Shift + ~" means hold down Shift, and press ~ .
  - "Press Alt, F" means press and release Alt, then press and release F.
- *Text in italics* is used for titles of manuals and diskettes and denotes words or phrases with special meaning.
- Text in ***bold italics*** is used for emphasis.
- `Text in Courier` represents messages issued by the system.
- `Text in` **`Bold Courier`** represents text you must type in. For example:

  At the prompt, type **`12`** and press Enter.
- Text in **Bold Regular** type represents actual software menu choices, button labels, or other text seen on-screen or on hardware that identifies software or hardware controls.
- Quotation marks ("_") identify sections and chapters within the manual.
- The words *select* and *highlight* are used interchangeably throughout the manual.
- **BOLD UPPERCASE** words in Warnings indicate the type of hazard explained. Read the Safety section in the beginning of this manual for more information.

# Technical Support and Service Procedures

## A Note to Our Customers . . .

We strongly encourage you to report any mechanical problems or operational difficulty with the system, whether major or minor. This helps us keep track of failures more accurately and helps us provide you with faster, more effective service.

## Gathering System Information

If you cannot correct a hardware or software problem using the information in this manual, write down the following information and have it ready ***before*** you request service:

- Type of system, model number
- All symptoms of the problem: frequency, application, reproducibility
- The current software revision level (appears in the Help|About window in Windows programs)
- The serial number of your system—look for the system label on the computer's rear panel. (Also note the computer revision level if the problem is computer-related.)

## Arranging for Service

Field Service personnel will attempt to determine the nature of the problem using the information you provide; generally, the cause can be quickly isolated. A replacement module, if required, can often be pulled from your Recommended Spares Kit or shipped to you via overnight courier.

### Customers in the U.S. And Canada

After you have gathered information about your system's hardware or software problem, please contact your nearest KLA-Tencor Customer Response Center. Customers in the United States can use our toll-free service line, 1-800-600-2829 or call (408) 468-3591. These numbers are available 24 hours a day, every day of the week.

### International Customers

Please contact your local KLA-Tencor office or the Customer Response Center for the quickest and most direct response to your service need. The number for the Customer Response Center in Europe is 44-118-936-5730. In Japan, the number is 0120-60-5858.

## Maintenance Charges

The following describes parts and labor charges for repairing or maintaining your system.

### If You Have a Warranty

Parts and labor are covered as stated in the product warranty. Replacement parts are shipped as soon as possible. Return all defective parts to KLA-Tencor within the specified time period.

### If You Do Not Have a Warranty

If your system is no longer under warranty, you must issue a purchase order (PO) before we can ship any parts. In general, KLA-Tencor will ship the parts after a PO number is phoned in; however, a hardcopy of the PO still must follow. KLA-Tencor publishes a price list of the most common replaceable parts.

## Returning Parts

Please call the Customer Response Center for shipping information ***before*** returning defective or unused parts for repair. You will be provided with a Return Materials Authorization (RMA) number which ***must be visible on the shipping carton.*** Also included will be directions on methods of packaging and transportation to ensure the safe and economical delivery of your returned items.

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# Chapter 1
# Safety

This chapter explains the differences between **NOTE**, **CAUTION**, **WARNING**, and **DANGER** messages. It also contains an overview of the safety-related issues that affect operation of the Quantox system.

This chapter describes

# Definitions of Hazard Keywords

## Note

**NOTE**

Notes indicate important information to help the user obtain optimum system performance. Notes are not safety-related.

## Caution

**CAUTION**

Cautions indicate that equipment or the environment can be damaged, or that data can be corrupted.

## Warning

**WARNING**

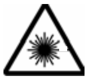
Warnings indicate a potentially hazardous situation which, if not avoided, ***could result*** in injury or death.

## Danger

**DANGER**

Dangers indicate an imminently hazardous situation which, if not avoided, ***will result*** in death or serious injury. This signal word is limited to extreme situations.

# Glossary of Warning Symbols

| | | | |
|---|---|---|---|
|  | General Warning |  | Fumes Hazard |
|  | Lifting Hazard |  | Chemical/Corrosion Hazard |
|  | Mechanical or Pinch Point Hazard |  | Cut/Sever Hazard |
|  | Shock Hazard |  | Fire Hazard |
|  | Poison Hazard |  | Heat Hazard |
|  | Explosion Hazard |  | IR Radiation Hazard |

# Input Power Safety Hardware, 200-mm Systems

## Emergency Machine Off (EMO) Switch

The Emergency Machine Off (EMO) switch is a red button on the front of the system, next to the monitor (Figure 1-1). Pressing the EMO button removes power from the system. Use it in situations that present immediate or imminent danger to life or equipment, such as during electrical malfunctions or chemical accidents, or when smoke or fire is observed.

**NOTE**

EMO switches are for emergency situations only, not for turning off the machine. To turn off the machine, set the Remote/Standby/On switch to Standby.

If the EMO switch is actuated, a qualified service engineer might need to restart the system and test it before the system can return to normal operation.

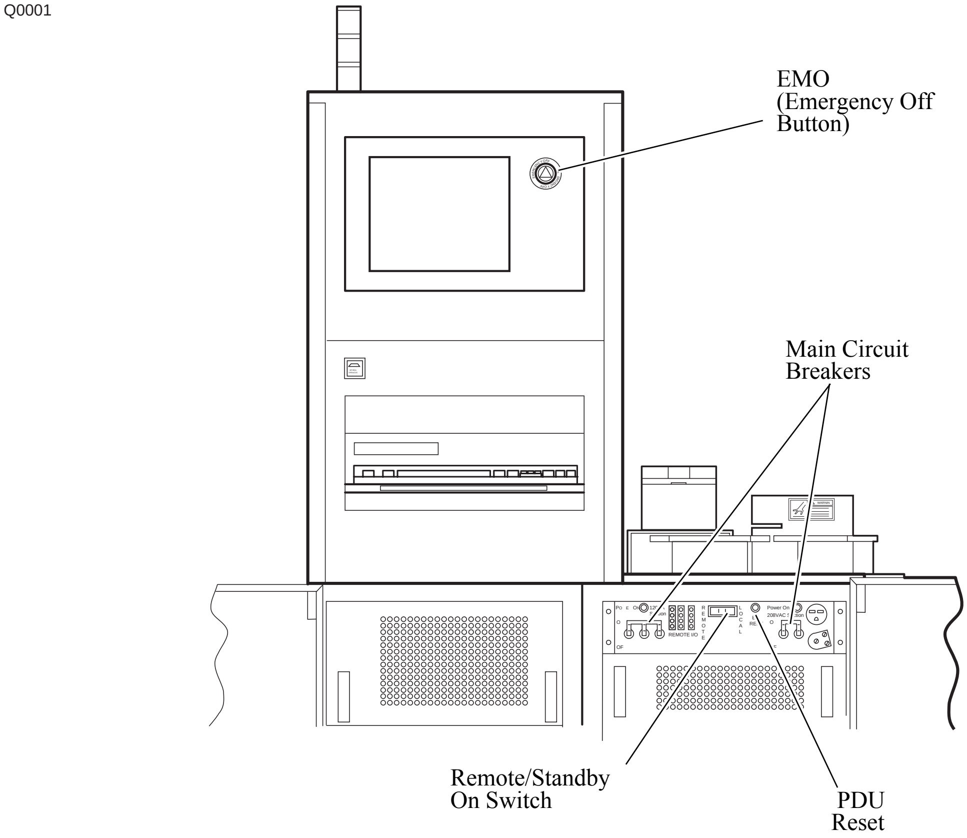


**Figure 1-1:** Control Tower, 200-mm Three-phase Quantox System

### Restoring Power After an EMO Shutdown

Before restarting the system, ensure that the components affected by the emergency shutdown procedure are thoroughly inspected. If smoke or fire was present, do not attempt to restart the system until ***all*** system components have been inspected by a qualified technician.

To restore power to a system that was shut down using the EMO switch, you must reset the EMO switch and the Power Distribution Unit (PDU). (The PDU must be reset whenever the EMO switch is activated or a main circuit breaker is tripped or turned off.) The procedure for restoring power is slightly different for three-phase 208VAC and single-phase 230VAC systems.

#### Three-phase 208VAC System

To restore power to the system:

1. Reset (close) the system EMO switch.

   To reset the EMO switch, press down on the EMO button with the palm of your hand and rotate the button $^1/_4$-turn clockwise until it releases and pops out.

2. Push the PDU Reset button to reset the PDU (Figure 1-1).
3. Cycle the Remote/Standby/On switch from Standby to On.

#### Single-phase 230VAC System

To restore power to the system:

1. Reset (close) the system EMO switch.

   To reset the EMO switch, press down on the EMO button with the palm of your hand and rotate the button $^1/_4$-turn clockwise until it releases and pops out.

2. Push the PDU Reset button to reset the PDU (Figure 1-2).

   On single-phase systems, you do not need to cycle the Remote/Standby/On switch after an EMO power down.

## Remote/Standby/On Switch

The Remote/Standby/On switch is a three-position rocker switch that is used to turn the system on or off. Place this switch in STANDBY (the center position) to turn the system off.

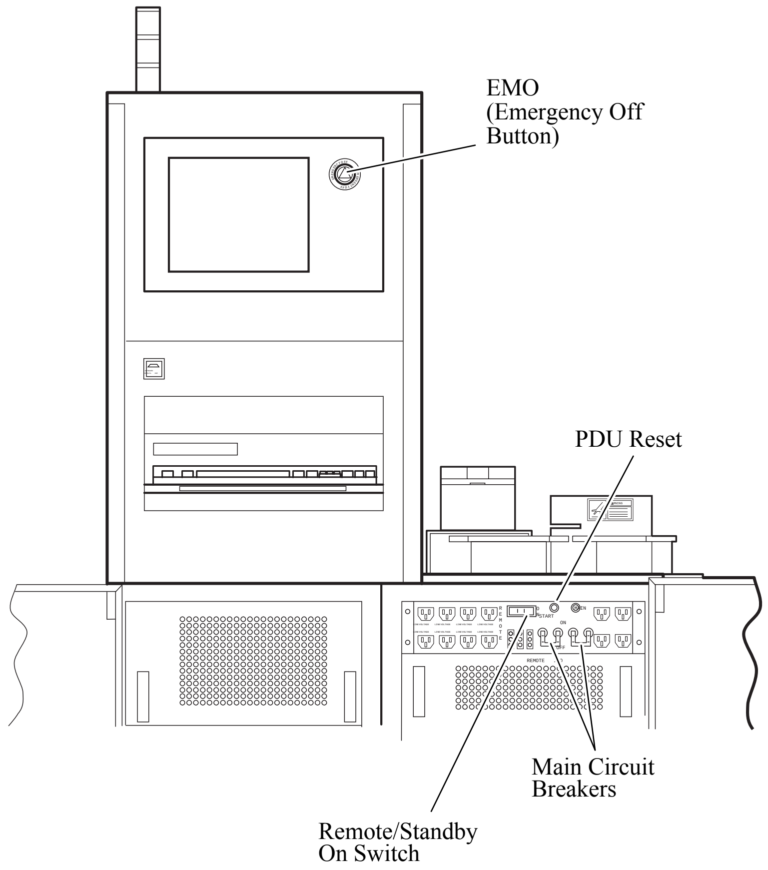


**Figure 1-2:** Control Tower, Single-phase System

## Main Circuit Breakers

The system is protected by two main circuit breakers. The circuit breakers turn off system power if the current passing through the circuit exceeds a certain limit. The system circuit breakers are different depending on whether the system is powered by three-phase 208VAC or single-phase 230VAC. See Figure 1-1 and Figure 1-2.

- On three-phase systems, one circuit breaker is located at the left side of the Pulizzi and is labeled Power ON 120 VAC. The other, to the right of the PDU Reset switch, is labeled Power ON 208 VAC.
- On single-phase systems, both circuit breakers are located below the PDU Start switch. The breaker on the left is labeled 15A and the one on the right is 3A.

If a circuit breaker is turned OFF or is tripped by a power surge, it must remain off for at least 10 seconds before being moved back to the ON position. After turning the circuit breaker to the ON position, you must reset the PDU to restore power to the system. On three-phase systems, you must also cycle the Remote/Standby/On switch from Standby to On.

# Input Power Safety Hardware, Quantox XP System

## Emergency Machine Off (EMO) Switch

The EMO buttons enable the operator to immediately shut off all power to the system and to place the system in a safe state. The red EMO buttons are surrounded by shrouds to prevent accidental shutoff.

- The main EMO is located on the user interface panel on the side of the tester unit (Figure 1-3)
- If the remote user interface option is installed, another EMO resides on the remote user interface panel (Figure 1-4).
- In addition, there are EMO switches on the rear of the unit above the utility connection panel and main circuit breaker and inside the rear doors, for use by service personnel.

The EMO circuit is activated by pressing any one of the EMO buttons.

**NOTE**

EMO switches are for emergency situations only, not for turning off the machine. To turn off the machine, use the OFF switch. Using the EMO switch to turn off the machine could damage the Trek 10/10 and High Voltage Control module.

### Restoring Power After an EMO Shutdown

Before restarting the system, ensure that a thorough inspection of the system has been completed with respect to all the components affected by the emergency shutdown procedure. If smoke or fire was present, do not attempt to restart the system until all components have been inspected by a qualified technician.

To reset (close) an EMO switch, press down on the switch with the palm of your hand and rotate the EMO button $^{1}/_{4}$ turn clockwise until the switch releases and pops up. Make sure to reset ***all*** EMO buttons.

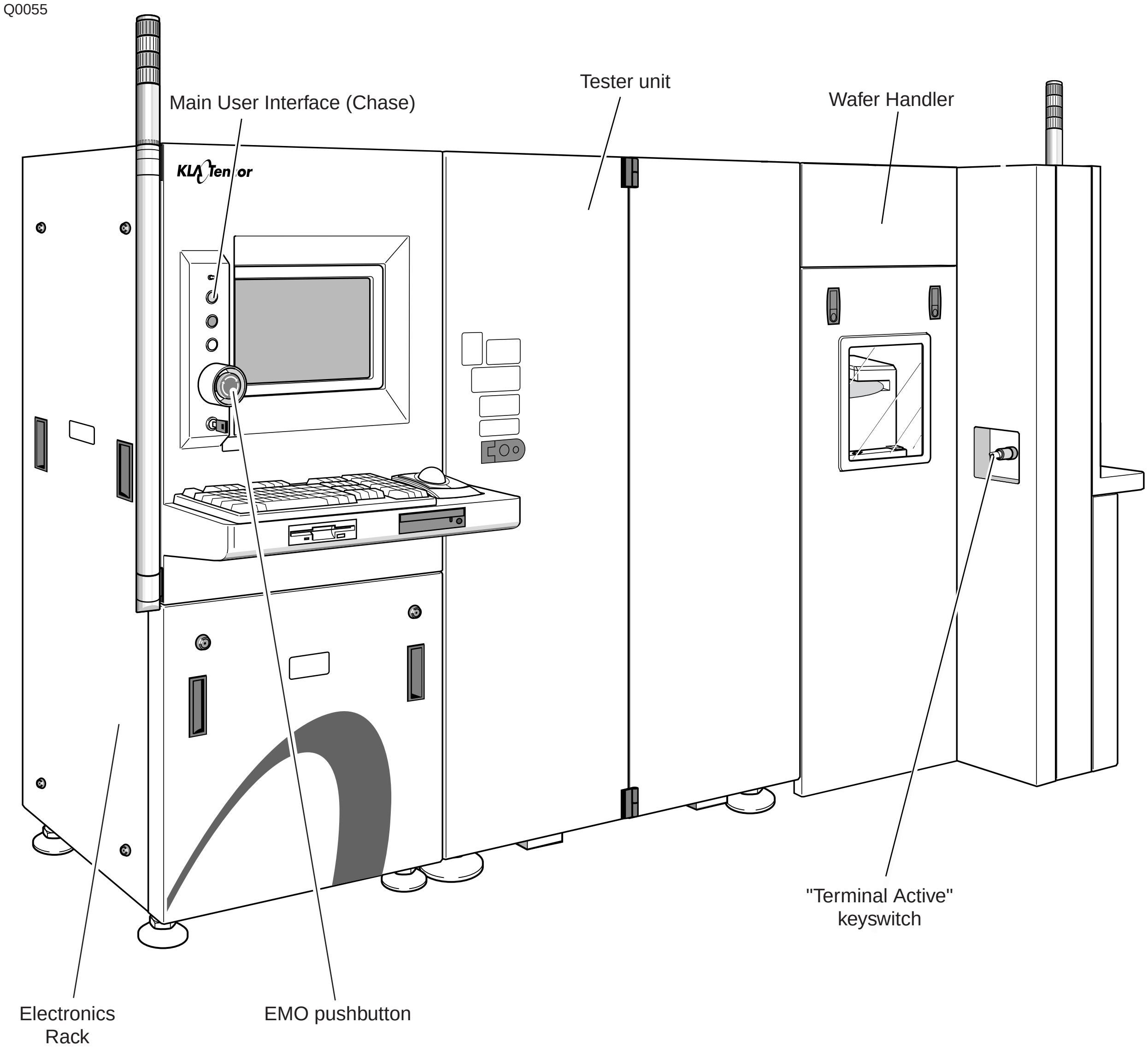


**Figure 1-3:** Main User Interface, “Terminal Active” Keyswitch, Quantox 300-mm System

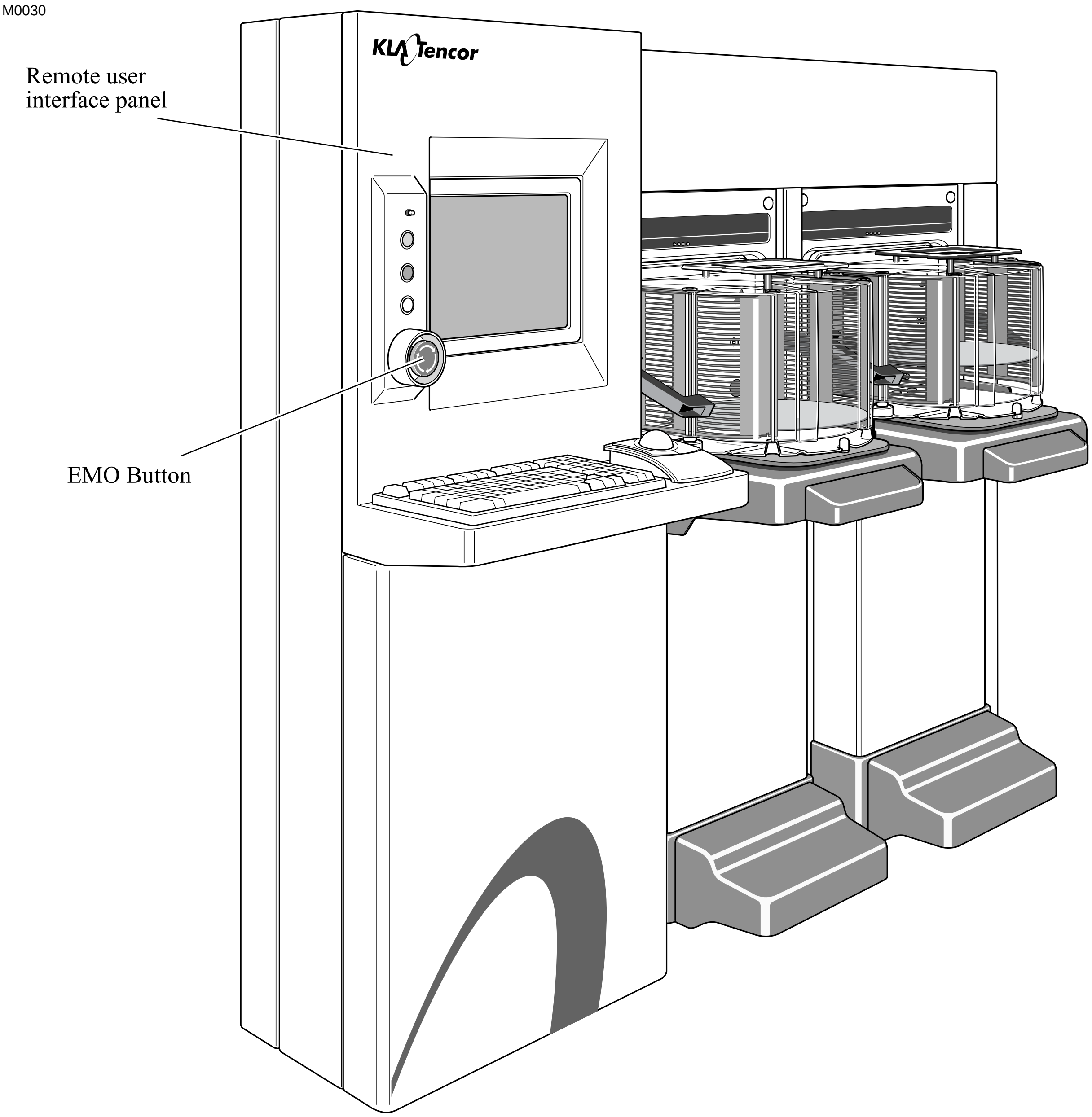


**Figure 1-4**: Remote User Interface Panel, 300-mm Quantox System

## Main Circuit Breakers

The system is protected by a main circuit breaker, which turns off system power if the current passing through the circuit exceeds a certain limit. The circuit breaker is mounted on the utility connection panel on the left rear of the measurement chamber (Figure 1-5 and Figure 1-6). If a circuit breaker is turned OFF or is tripped by a power surge, it must remain off for at least 10 seconds before you can move it back to the ON position.

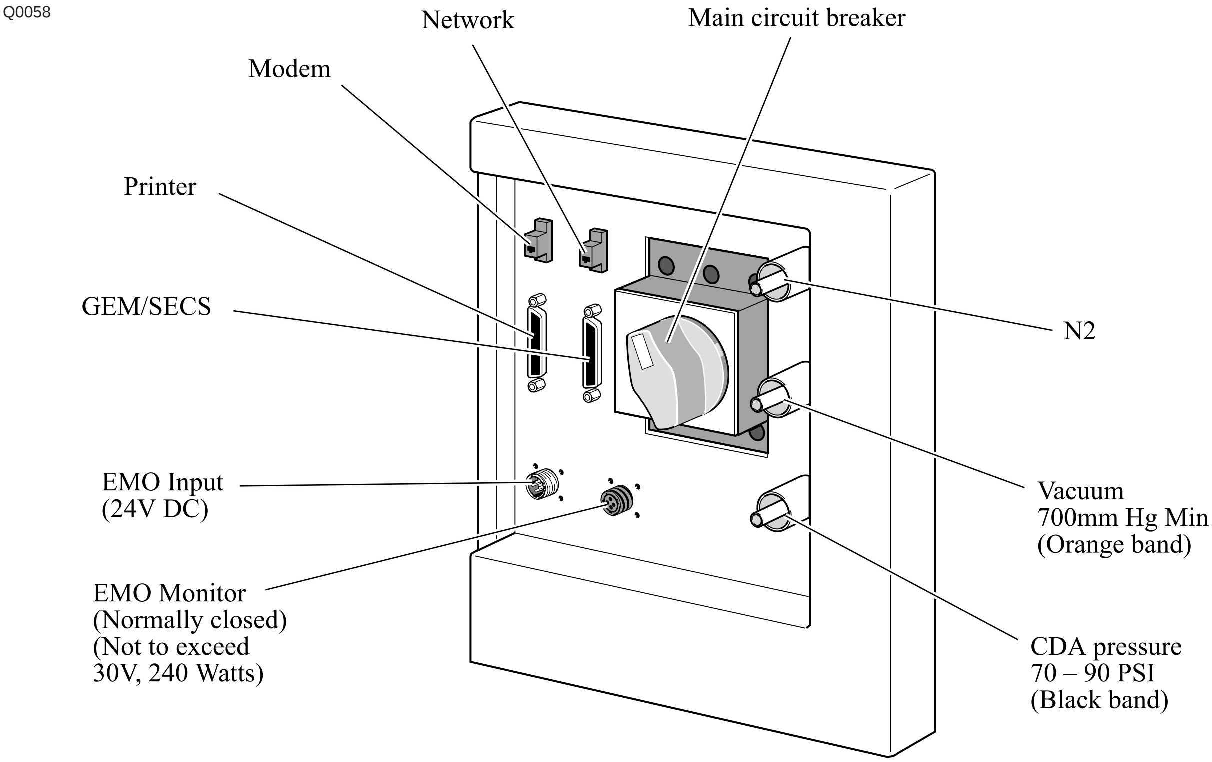


**Figure 1-5**: Utility Connection Panel and Main Circuit Breaker, 200-mm System

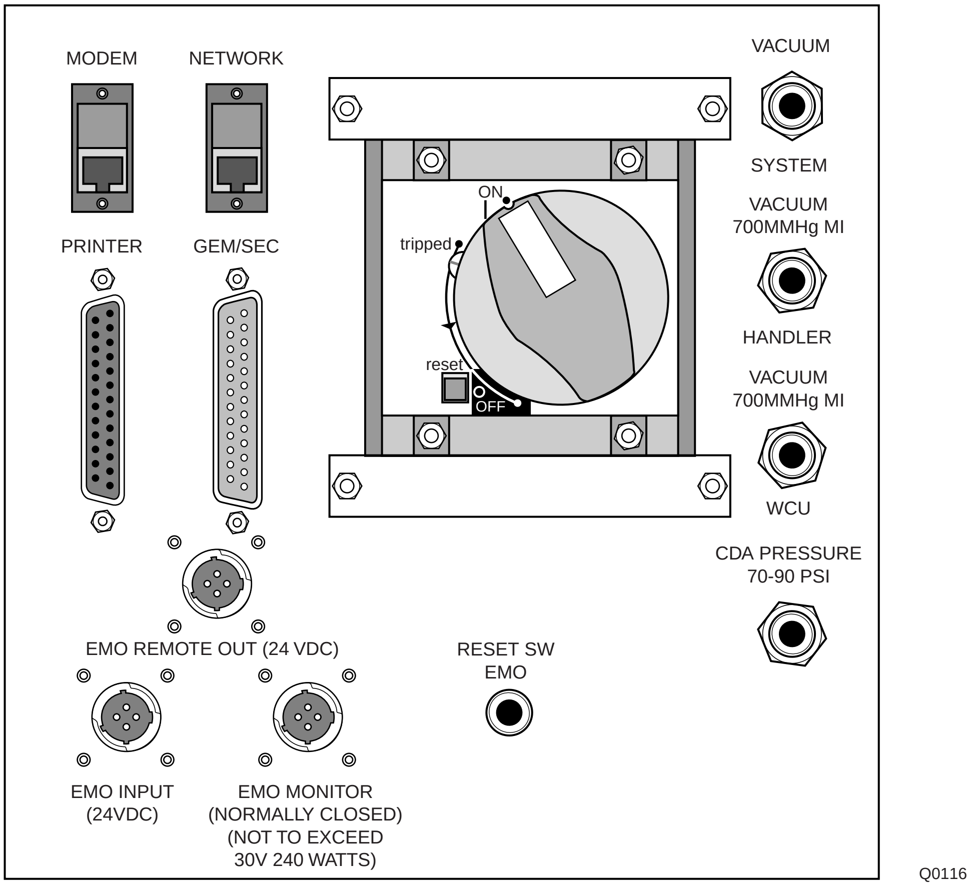


**Figure 1-6** Utility Connection Panel and Main Circuit Breaker, 300-mm System

# Electrical Hazards

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**WARNING**

**HIGH-VOLTAGE ELECTRICAL SHOCK HAZARD:**

The following five types of electrical hazards can exist in any kind of electrical equipment, ranging from the safest (Type 1) to the potentially most dangerous (Type 5):

**Type 1** — Equipment is fully de-energized.

**Type 2** — Equipment is energized, but live circuits are covered or insulated to prevent accidental shock.

**Type 3** — Equipment is energized and live circuits of less than 30 Vrms, 240 VA, or 20 joules are exposed to accidental contact.

**Type 4** — Equipment is energized and live circuits of greater than 30 Vrms, 240 VA, or 20 joules are exposed to accidental contact; or radio frequency (RF) is present.

**Type 5** — Equipment is energized and adjustment requires physical entry into the equipment, or equipment configuration does not allow the use of clamp-on probes.

Quantox normal operations typically present Type 2 hazards when the equipment is energized, since all live circuits are covered and removing panels is not allowed during normal operations.

**WARNING**

**ELECTRICAL HAZARD** The Tester’s AC and DC power modules, the light box, the oven controller and the Wafer Handler’s power distribution box may be opened ONLY by authorized service personnel.

# Laser Safety

## Wafer Handler, 200-mm Systems

The wafer-handling robot uses a semiconductor laser to scan the cassette nest and identify which locations contain wafers. The laser sensor is enabled only during scanning operations. The laser sensor is a Hama Labs WX-43PI with a maximum output of 2 × 0.2 mW at 800 nm, invisible. The WX-43PI sensor is certified as a stand-alone Class I laser product under the Center for Device and Radiological Health (CDRH) Radiation Performance Standard. This laser does not pose any hazard to operators or service personnel performing robot training or other maintenance work.

**WARNING**

**LASER** The wafer handler uses a class IIIb laser operating at a wavelength of 800nm with a maximum output of 2 × 2.4 mW. During scanning operations, the laser operates as a Class I laser.

Serious eye injury or blindness may result from exposure to laser radiation. Wear laser protective goggles at all times when performing maintenance on this laser. Do not look directly into the source of the beam at any time.

### Note to Users of DD-50 Lasers

Early Quantox machines used a Hama Labs DD-50 laser sensor instead of the lower power WX-43PI. The DD-50 produces a maximum output of 2 × 2.4 mW at 800nm, invisible. While the DD-50 is rated as a stand-alone Class IIIb laser product, during the scanning operations it is certified as a Class I laser product under the Center for Device and Radiological Health (CDRH) Radiation Performance Standard (no operation hazard). The scanning motion limits total exposure to non-hazardous levels even if a user’s eye is in line with the beam.

The laser is designed to operate only during the scanning operation. If the robot’s motion is blocked or slowed down, the robot’s control voltage exceeds the threshold level and the robot and laser power is turned off. Once the problem is cleared, the unit may be restarted.

During installation and training of the robot wafer handler, the laser may be turned on when the robot arm is not moving. A red LED on the laser sensor illuminates when the laser output is on. Under these conditions, the DD-50 laser sensor is operating as a Class IIIb laser device.

## Optional SMIF Indexer

**WARNING**

**LASER** The SMIF indexer employs a class IIIa laser, operating at a wavelength of 670 nm with a maximum output of less than 3 mW. During scanning operations, the laser is completely enclosed and operates as a Class I laser.

Serious eye injury or blindness may result from exposure to laser radiation. Do not remove the cover from the laser. Wear laser protective goggles at all times when performing maintenance on this laser. Do not look directly into the source of the beam at any time.

The SMIF indexer determines the index position of the wafers by scanning for the index flat.

## Wafer Handler, 300-mm Systems

Refer to the Safety chapter of the Wafer Handler Maintenance manual from the ASD division of KLA-Tencor.

## Optional Iron Head

**WARNING**

**LASER** The optional iron head employs a class IIIb laser, operating at a wavelength of 790nm with a maximum output of 100 mW. During scanning operations, the laser is completely enclosed and operates as a Class I laser.

Serious eye injury or blindness may result from exposure to laser radiation. Do not remove the cover from the laser. Wear laser protective goggles at all times when performing maintenance on this laser. Do not look directly into the source of the beam at any time.

Internal to the optional iron head, there is a semiconductor laser to apply energy to the wafer for certain measurements. Laser light is conducted through a fiber optic cable to the test head where it is pointed at the wafer. It is a Class IIIb laser with maximum output of 100 mW at a wavelength of 790 nm (invisible, near-infrared light). This laser is completely enclosed within the measurement chamber and access is restricted to service personnel only by use of key locks on the service panels. Because operator access has been eliminated, the laser has been certified as a Class I laser product under the Center for Device and Radiological Health (CDRH) Radiation Performance Standard (no operation hazard).

# Robot Safety, ATM-100 Robot/Controller Package

**WARNING**

**MECHANICAL HAZARD** Contact with the robot’s moving parts may result in personal injury and/or damage to the robot.

Do not attempt to grasp or physically interfere with the robot while it is in motion or energized.

**WARNING**

**LASER** Serious eye injury or blindness may result from exposure to laser radiation.

Wear laser protective goggles at all times when performing maintenance on this laser. Do not look directly into the source of the beam at any time.

The ATM-100 robot/controller package incorporates safety features designed to disconnect power to the motors in the event the robot motion is obstructed. Even though this safety feature is present, always remain clear of the robot’s path of movement during operations.

During normal operation, when the laser is on and the robot arm is moving, no eye protection is required. Although eye protection is not required, avoid direct eye exposure with the laser. Note that the red Laser LED, mounted on top of the laser, lights whenever the laser activates. For additional safety information regarding the laser refer to “Optional SMIF Indexer” on page 1-14.

# X-Y Stage Hazard

**WARNING**

**PINCH HAZARD** The Quantox X-Y stage subsystem contains moving parts that may cause bodily injury.

Keep hands clear of the measurement chamber. Observe standard mechanical safety practices at all times.

# Hotplate/Oven Hazard

**WARNING**

**BURN HAZARD** Severe burns may result from contact with the hot plate/oven. The surface temperature may be as high as 300°C (572°F).

Do not touch it at any time.

# Ergonomic and Human Factors

- Avoid eye strain and possible headaches by looking away from the monitor every few minutes. Also, look at objects at various distances.
- Vary your tasks. Do not perform repetitive tasks with your hands without interruption. Do not work intensely in the same body position for long periods of time.
- Avoid extreme bending, angling, or arching of your wrists.
- Do not rest your wrists on the edge of the keyboard platform while typing.
- Do not rest your wrists in an angled position for more than a brief period.
- Keep your elbows in a relaxed position near your body.
- Keep your fingers and thumbs in a relaxed, natural position.
- Use the minimum amount of force required to push down the keys.

# Location of Hazard Labels

Safety labels are affixed to the exterior of the systems at the locations shown in Figure 1-7 through Figure 1-10. The safety labels shown in these figures are installed at the factory.

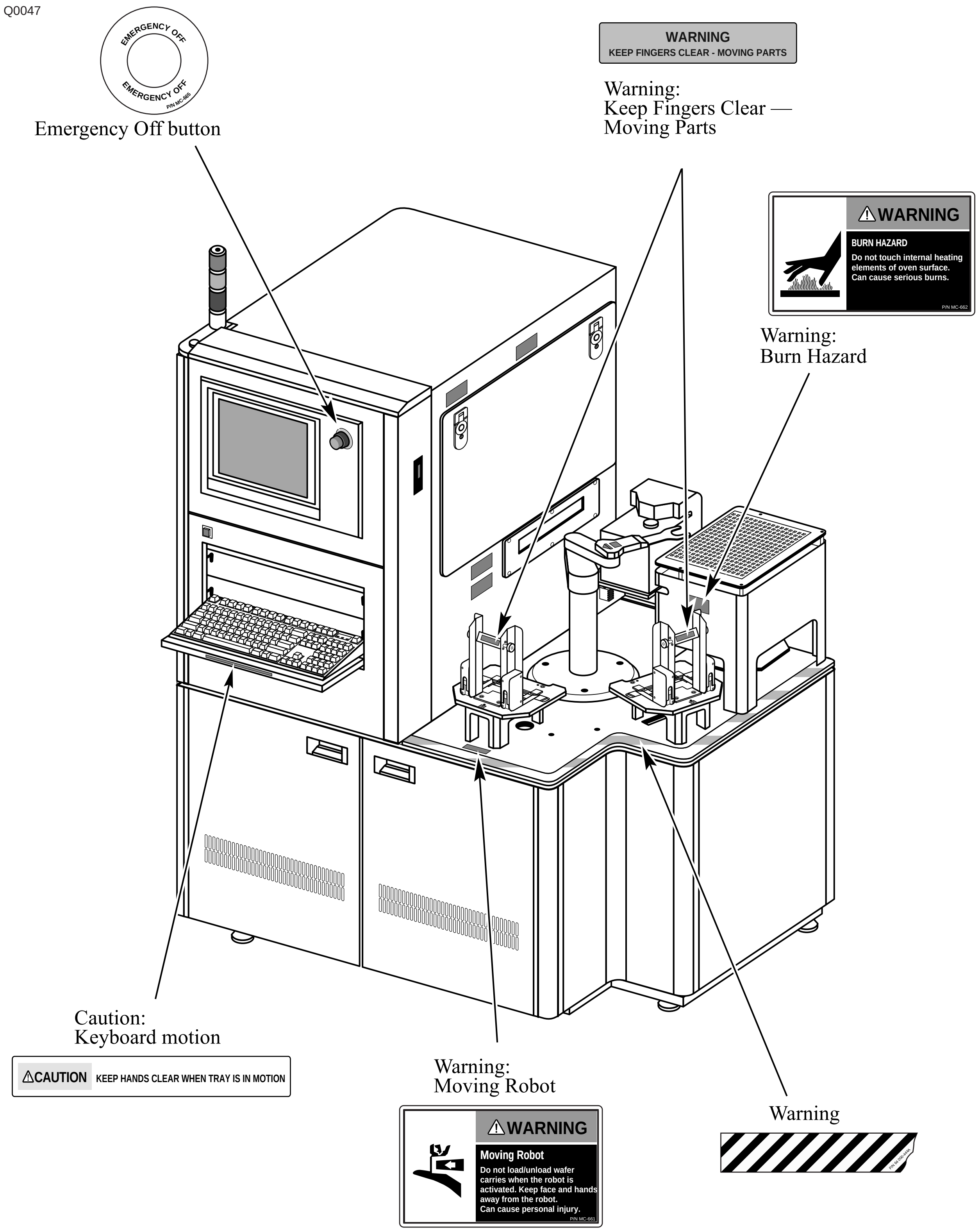


**Figure 1-7:** Safety Label Locations, 200-mm System (Front)

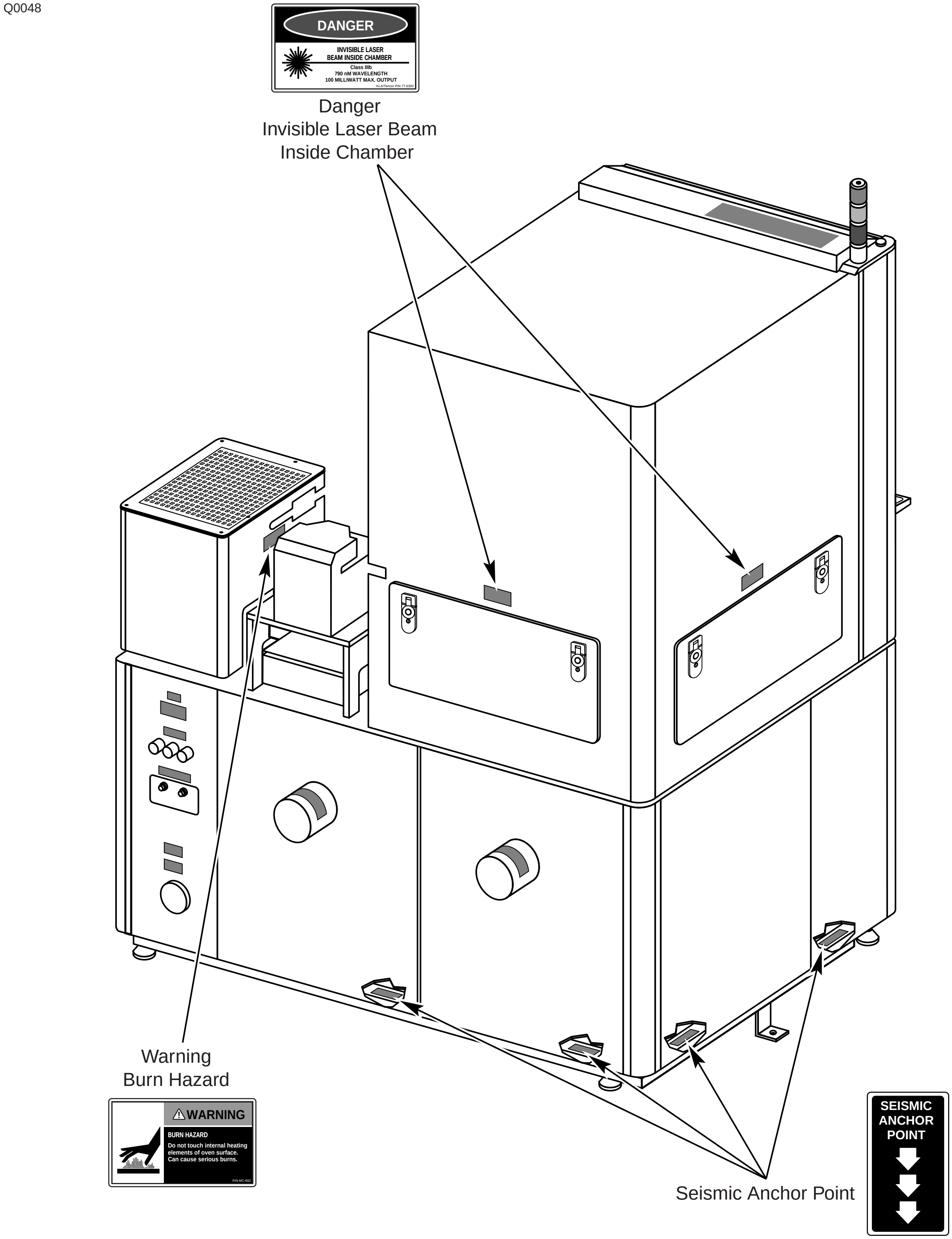


**Figure 1-8**: Safety Label Locations, 200-mm System (Rear)

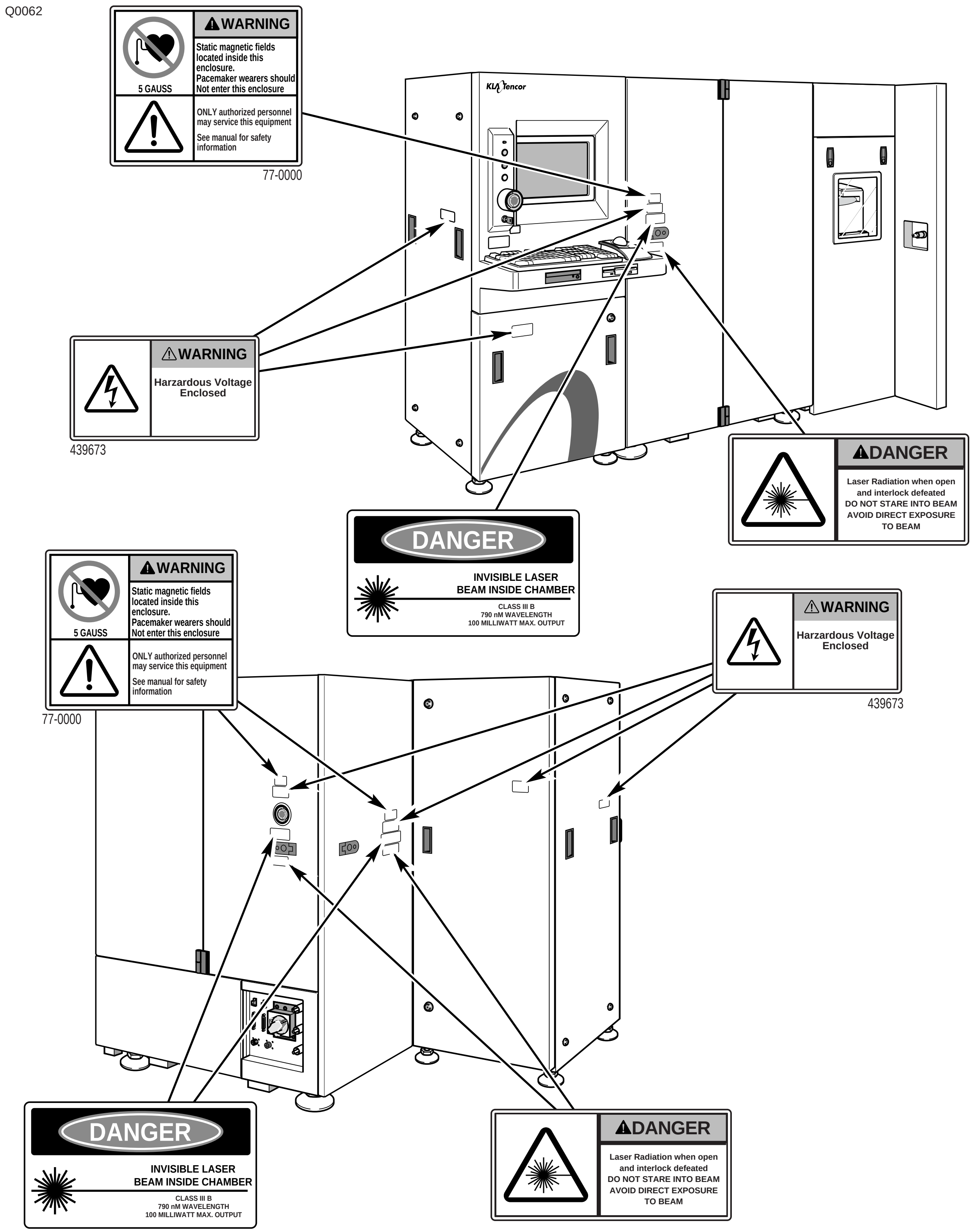


**Figure 1-9:** Safety Label Locations, 300-mm (External)

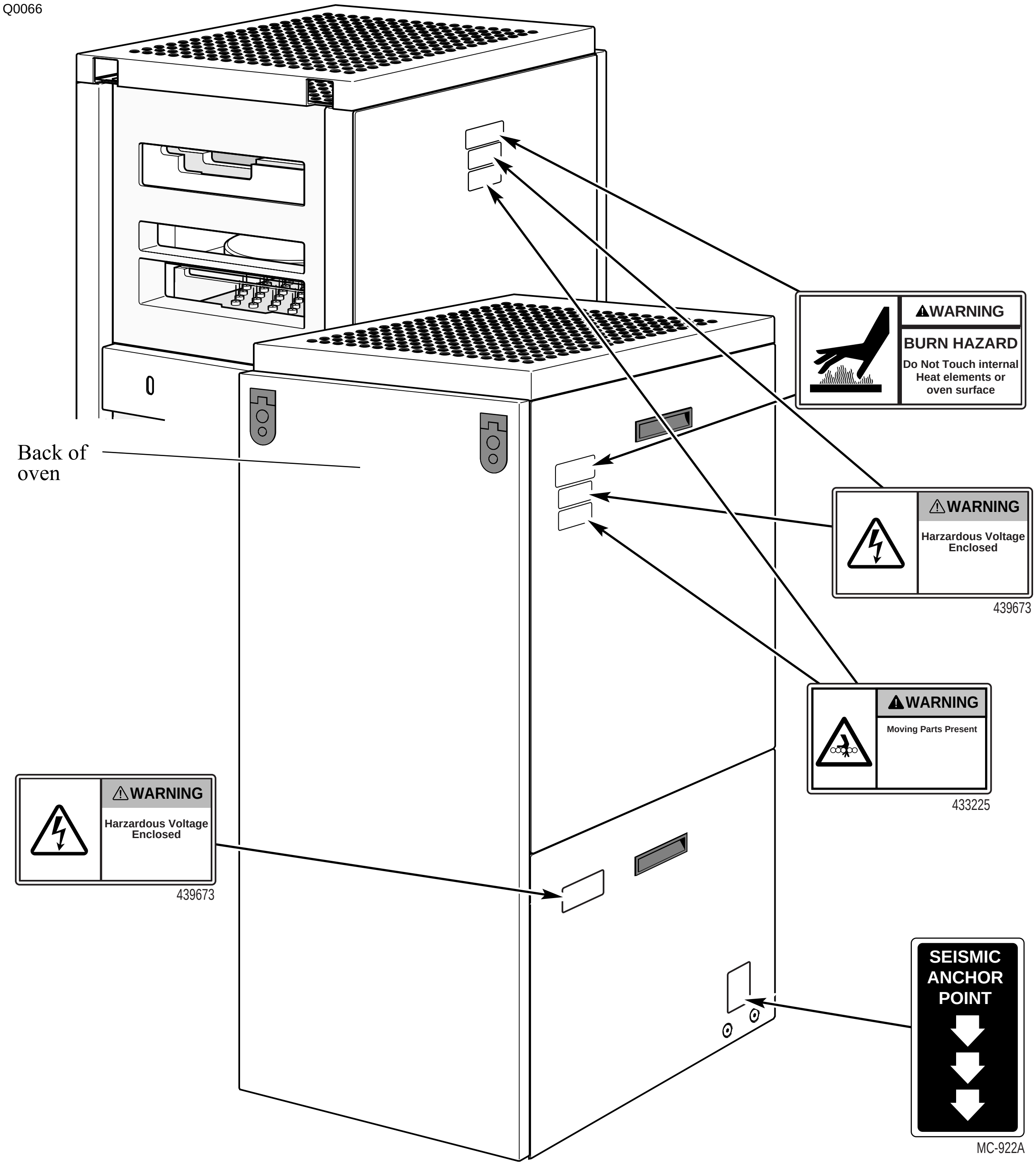


**Figure 1-10**: Safety Labels, 300-mm System Oven

# Chapter 2
# System Overview

The Quantox® system is a measurement tool for quantifying oxide characteristics. The system improves processing capabilities by reducing the time required to gather information for monitoring critical oxides and oxide-related processes. The measurement principles employed by the system are highly analogous to MOS C-V with the advantages of non-contact technology.

The Quantox system provides highly detailed information that goes beyond a simple net charge value, breaking the electrical charge contamination into individual categories. The system also provides electrical measurement of oxide thickness to less than 4 nm and produces maps that are unavailable in traditional C-V methods.

This chapter describes

# Physical Description

The Quantox system is a cleanroom-compatible system composed of five major components and subsystems:

- Operator User Interface (UI): Main UI and optional Remote UI.

  The Remote User Interface option for 300-mm systems is bulkhead mounted. It attaches to the wafer handler just to the left of the load ports and is accessible from the fab bay.
- Wafer Handler: 200- or 300-mm capability (Quantox XP)
- Tester: X-Y stage and controller, chuck assembly, electronic control modules
- Electronics subsystem: AC and DC power distribution modules, high voltage systems, electronic systems
- (Optional) Wafer Conditioning Unit for 300-mm systems: heater and cooler

# System Controls and Indicators, 200-mm System

All operator controls and indicators for the Quantox 200-mm system are located on the control tower. Figure 2-1 shows the locations for a three-phase system while Figure 2-2 shows the locations for a single-phase system.

**NOTE**

Refer to Chapter 1 for information on the EMO button, circuit breakers, and power switches.

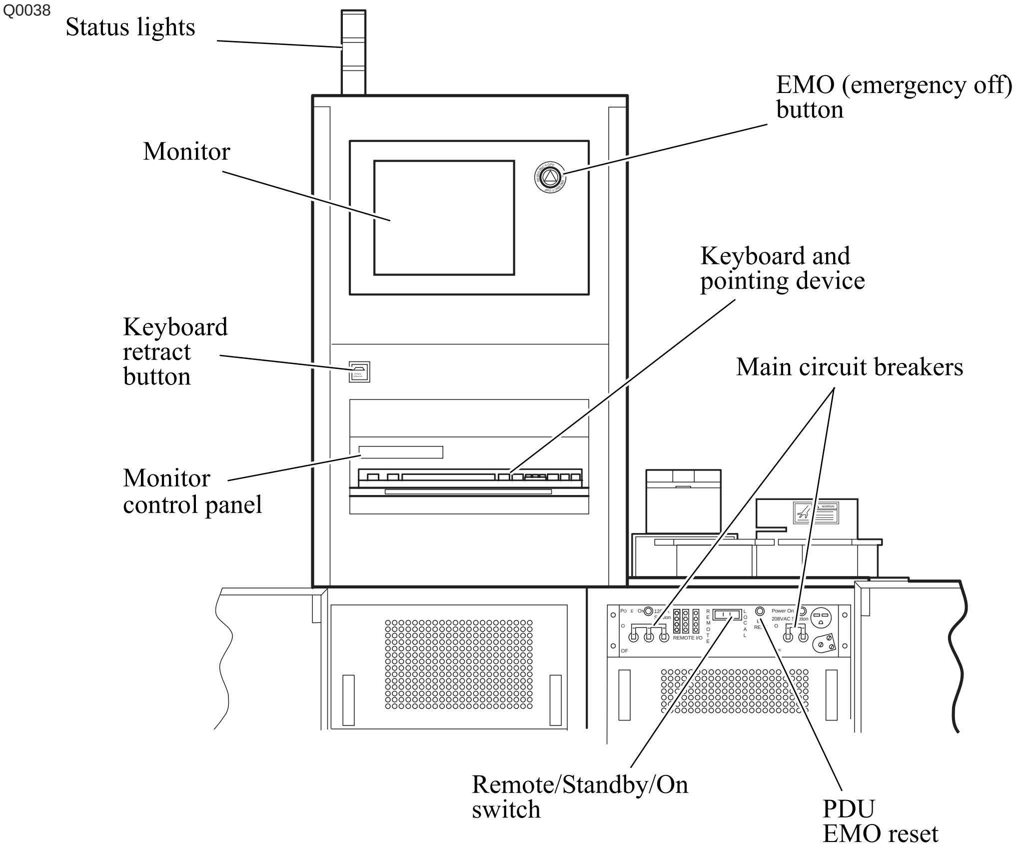


**Figure 2-1**: Control Tower, 200-mm Three-Phase System

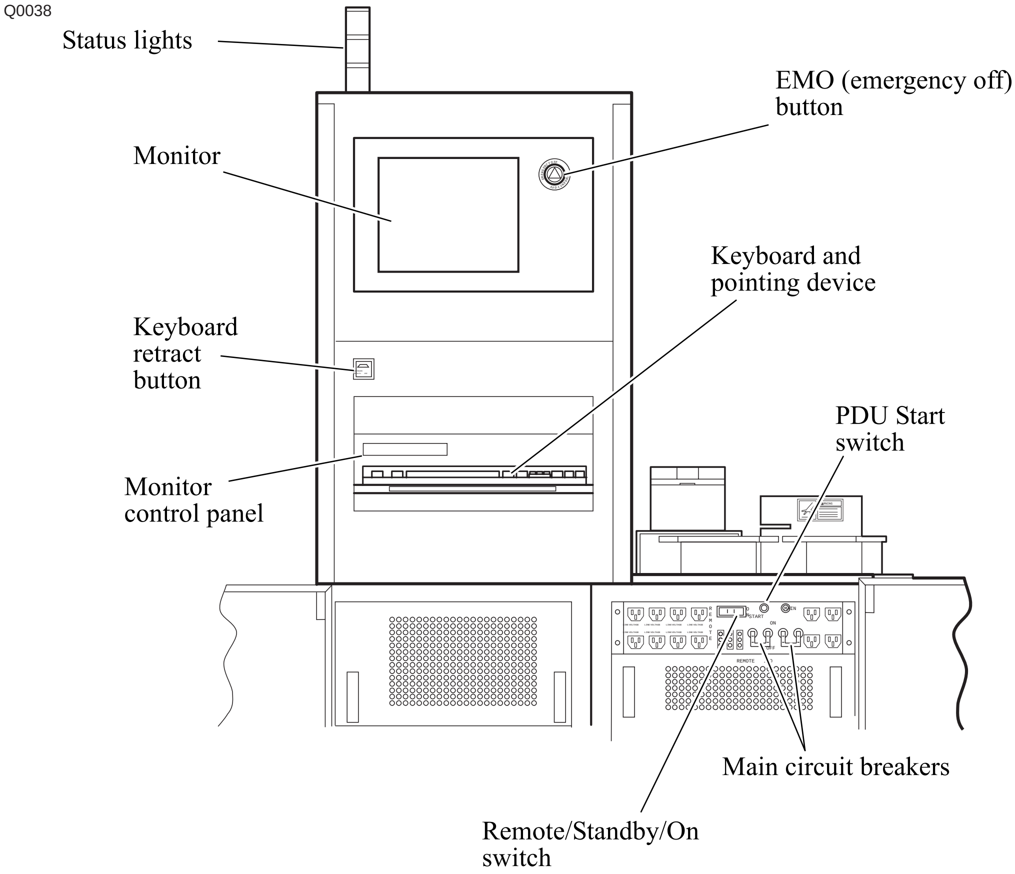


**Figure 2-2**: Control Tower, 200-mm Single-Phase System

## Status Lights

The status lights are configured to report a set of defined equipment events. Table 2-2 describes the factory default settings for the system status lights. Settings can be modified from within the Quantox Operator Interface program (see “Light Bar” on page 4-18).

**Table 2-1**: Default Configuration of Status Lights

| Light color (state) | Meaning |
|---|---|
| Green light (steady) | Quantox has been initialized |
| Green light (flashing) | A test is running on the machine |
| Yellow light (flashing) | Test completed |
| Red light (flashing) | Error |
| Red light (steady) | Quantox turned on but initialization not complete |

# System Controls and Indicators, Quantox XP System

The Quantox XP Main User Interface (UI) provides the operator with the following controls and indicators:

- "Terminal Active" Indicator Light (not used with single-UI systems)
- Buzzer Silence button (blue)
- System Power ON button (green)
- System Power OFF button (gray)
- Emergency Machine Off (EMO) pushbutton (red)
- Interlock Override Keyswitch

Systems equipped with the optional Remote User Interface have a control panel identical to that on the Main UI, but without the interlock override keyswitch.

The actual switching of control between the User Interfaces is done at the Terminal Active keyswitch, located at the back of the Remote User Interface (see Figure 1-3). The Terminal Active keyswitch cannot be accessed from the fab side of the bulkhead; its use is restricted to service personnel in the chase (Tester) area. Control of the tool is switched to the Main UI in the chase area when the key is turned to the right, or switched to the remote (fab) UI when turned to the left. The key is held captive in the service (Main UI) position, and is removable when control is returned to the bay (remote UI).

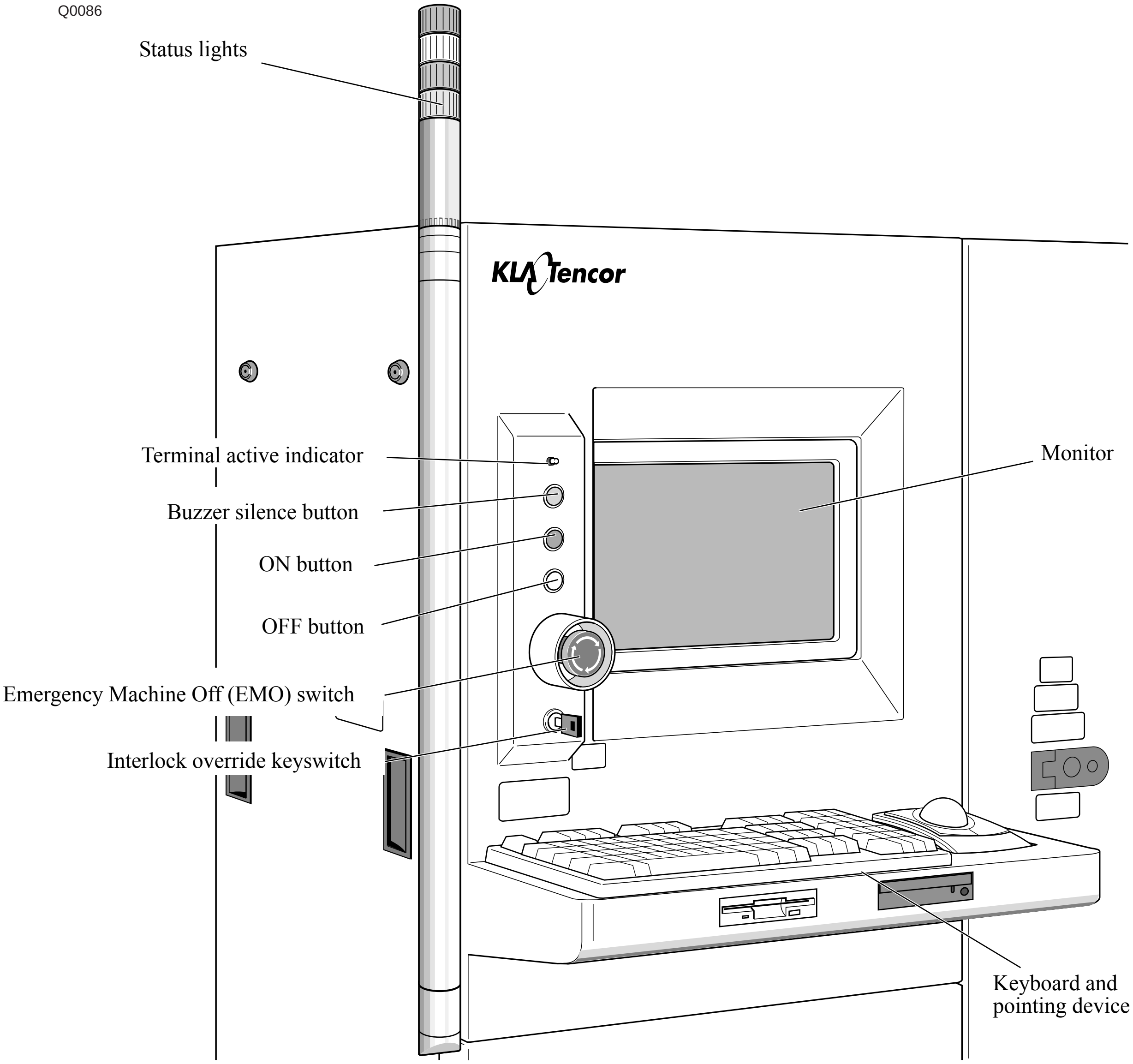


**Figure 2-3**: Main User Interface, Quantox XP System

### Terminal Active Indicator Light

The "Terminal Active" indicator light is ON when the terminal on which it is located is currently controlling the system. This light is only used when there is more than one User Interface attached to the system (on a bulkhead mounted tool).

### Buzzer Silence Button

The buzzer silence button turns off the buzzer alarm that sounds when any customer-defined processing malfunction occurs.

### System Power On Button

The power ON button is used to turn power on to the entire system. When activated, power is supplied to all components of the system, including the handler. The handler does not have a secondary power switch that the user must activate in order to activate the handler. The ON button is not a toggle switch. It does not turn the system off if pressed a second time.

The ON button should always be used to restore power any time the system is de-energized by one of the following:

- orderly system shutdown (pressing the OFF button)
- emergency shutdown (pressing EMO pushbutton)
- facility power outage or interruption
- tripping of main breaker
- turning off main breaker

### System Power Off Button

The OFF button is used to remove power from all system components (including the wafer handler) as the final step of an orderly shutdown. Before using the OFF button, the system software must first be shut down using the proper power down procedure.

Each User Interface has an OFF button. These buttons can be used to shut the system down from either UI, whether that UI is currently being used to control the tool or not. Pressing the OFF button on an "inactive" UI shuts down the system.

---

**CAUTION**

**Never use the OFF button for an emergency shutdown**. Always use the EMO buttons in an emergency. Use the OFF button only for orderly shutdowns. If, in an emergency situation, you mistakenly use the OFF button to shut down the system, simply press the EMO button after pressing the OFF button to take advantage of the extra layer of safety an EMO shutdown provides.

---

### EMO Pushbutton

In addition to several other EMO pushbuttons located on the tool, each User Interface has an EMO pushbutton on the control panel. The EMO pushbuttons are shrouded by a plastic collar and slightly recessed within the collar to prevent accidental activation.

### Interlock Override Keyswitch

At the bottom of the UI control panel is the interlock override keyswitch. This switch is used only during maintenance and service procedures which require the more hazardous parts of the system to be operational with the outer panels off. Turning the key clockwise overrides the interlocks; turning it counterclockwise restores the interlock protection. The key is held captive in the override position so that the tool cannot be left in that condition without a means of restoring the interlock safety feature.

---

**CAUTION**

Only trained KLA-Tencor service personnel are authorized to override the Quantox XP interlock system. Interlock safety features should only be defeated when necessary for specific service procedures. Interlock protection should always be restored promptly upon the completion of such procedures. Always remove the interlock Override key from the control panel and secure it when service tasks are finished.

---

## Status Lights

The status lights are configured to report a set of defined equipment events. Table 2-2 describes the factory default settings for the system status lights. Settings can be modified from within the Quantox Operator Interface program (see "Light Bar" on page 4-18).

**Table 2-2**: Default Configuration of Status Lights

| Light color (state) | Meaning |
|---|---|
| Green light (steady) | Quantox has been initialized |
| Green light (flashing) | A test is running on the machine |
| Yellow light (flashing) | Test completed |
| Red light (flashing) | Error |
| Red light (steady) | Quantox turned on but initialization not complete |

# System Startup

Before attempting to power up the Quantox system, ensure that everything is set up properly and that there are no obstructions within the wafer handling area. Once everything has been checked and found ready to go, apply power to the system.

## Logging On to the System

When the computer system powers up, Windows NT starts automatically, and the Windows NT logon dialog box opens. The user must enter a logon name, domain, and password to access the system.

There are four user accounts available:

- Administrator
- Engineer
- Operator
- Service

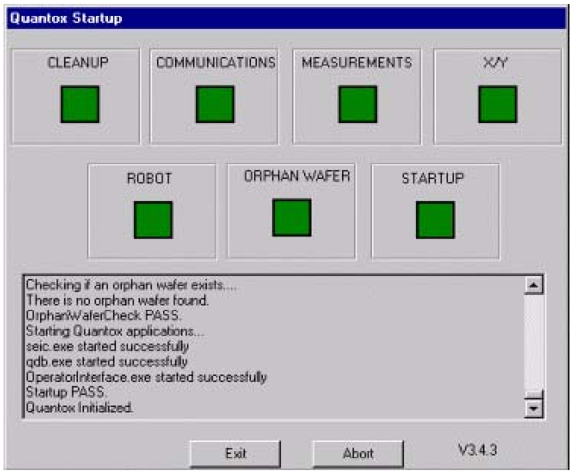
The Administrator account is used for system administration tasks and to load or upgrade the Quantox software package. The engineer and operator accounts give the user access to the programs necessary to operate the system. The service account is set up for field service and maintenance activities and should only be accessed by KLA-Tencor trained personnel.

## Running the Quantox Startup Program

After logging on to the Quantox system, you can initiate the Quantox startup program by selecting it from the Quantox program group. The startup program initializes the electronic and mechanical subsystems of the tool. As the system initializes, the robot arm slowly moves to its home position.

After initialization, the system checks for any wafers that have been stranded (perhaps as the result of a power failure). If a stranded wafer is located, the system instructs the user to enter the cassette position and slot where the wafer should be returned.

The Quantox startup program takes several minutes to complete. At this point, the Quantox Startup window looks as shown in Figure 2-4. When the program finishes, the monitor displays the operator interface.



```
Checking if an orphan wafer exists....
There is no orphan wafer found.
OrphanWaferCheck PASS.
Starting Quantox applications...
seic.exe started successfully
qdb.exe started successfully
OperatorInterface.exe started successfully
Startup PASS.
Quantox Initialized.
```

**Figure 2-4**: Startup Program Screen When Startup is Complete

# System Shutdown

To shut down the Quantox computer system, exit Windows NT through normal shutdown procedures. After the message “It is now safe to turn off your computer.” shows on the screen, you can remove power from the computer. After the computer has shut down, you can remove power from the system.

**CAUTION**

If this shutdown procedure is not followed as described, a problem can occur when you restart the computer and boot up the Quantox software.

# The Quantox Software Suite

Quantox software comprises a suite of programs designed to enable the system user to define wafer tests and collect and analyze test data. The following sections introduce these programs:

- "Quantox Recipe Builder" on page 2-13
- "Quantox Operator Interface" on page 2-19
- "Quantox Operator Interface Automator" on page 2-20
- "Quantox Report Generator" on page 2-21
- "Quantox Data Wizard" on page 2-23

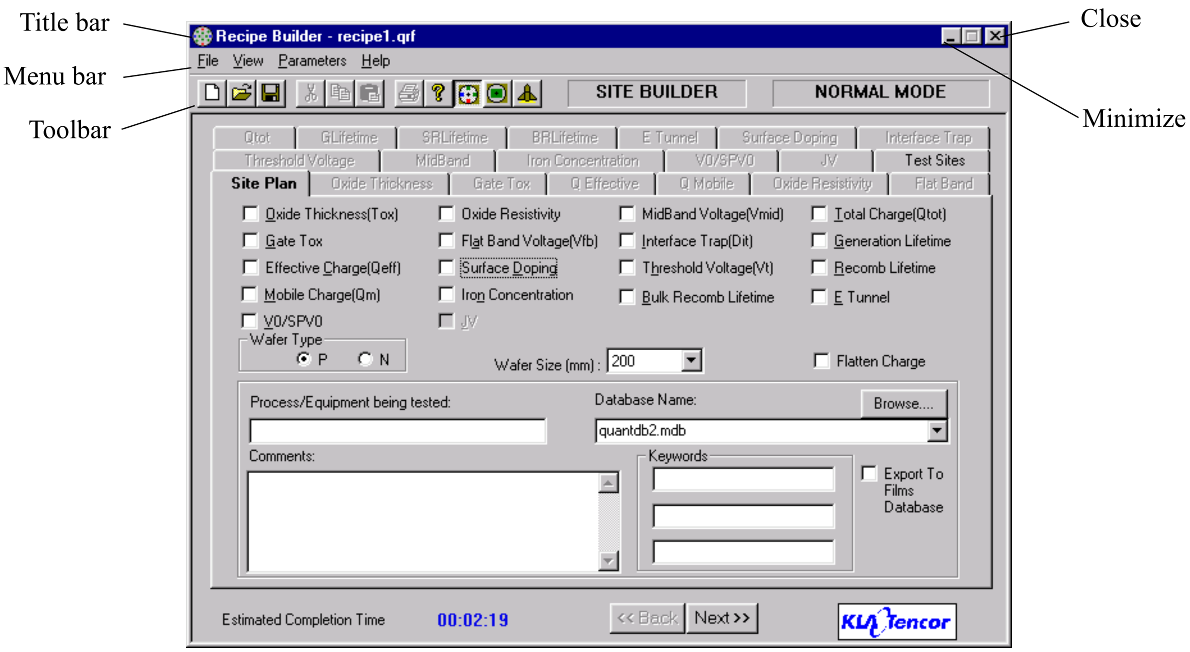
With the exception of Data Wizard, the user accesses these programs from the Quantox Program Group by selecting Programs | Quantox from the Microsoft Windows NT Start menu. Data Wizard is a plug-in to Microsoft Excel and is run from within Excel.

**NOTE**

Detailed instructions for using these programs are provided in subsequent chapters of this manual.

# Quantox Recipe Builder

The Quantox Recipe Builder (QRB) program (Figure 2-5) comprises a collection of tabbed dialog boxes (*pages*) used to select the tests, define the testing parameters, and identify the test sites that comprise a recipe. The test engineer uses the computer keyboard and pointing device to navigate the pages and enter the required information.



Wafer Type: ● P ○ N

Wafer Size (mm) : 200

Database Name: quantdb2.mdb

Estimated Completion Time 00:02:19

**Figure 2-5**: Recipe Builder

---

**NOTE**

Depending upon the licensed options, certain measurement selections might be grayed-out and unavailable.

---

## Title bar

The Title Bar displays the name of the system and provides buttons for minimizing, maximizing, and closing the window.

# Menu bar

The menu bar contains the following pull-down menus.

### File Menu

| | |
|---|---|
| New | Clears the entries in the Recipe Builder so that a new recipe can be defined. |
| Open | Opens an existing recipe. |
| Save | Saves the recipe under the current name. If the user modifies a recipe and then Saves it (rather than using Save As to rename it) the original recipe is overwritten. The Save window also enables you to delete a recipe by selecting the recipe and clicking the Delete Recipe button.<br>Recipe files (*.QRF) are stored in *Book* subdirectories within *Library* directories. Libraries reside in C:\Quantox\Recipes. |
| Save As | Enables the recipe to be saved with a new name. The Save As window also enables you to delete a recipe by selecting the recipe and clicking the Delete Recipe button. |
| Recent File | (currently disabled) |
| Import | (currently disabled) |
| Export | (currently disabled) |
| Exit | closes the Recipe Builder |

### View Menu

| | |
|---|---|
| Site Tests | used to define site-based tests |
| Map Tests | used to define map-based tests |
| Advanced Features | activates the Advanced Mode. The Advanced Features mode gives the user greater control over the testing process. Features vary from test to test and might include settings for wafer preheat, charge bias, or the use of the backside contact.<br>Most tests offer Advanced Features, and features offered for multiple tests are linked together (deselecting a feature for one test deselects it for all tests). |
| Toolbar | toggles the toolbar on or off |

### Parameters Menu

| | |
|---|---|
| Wafer Description | used to describe the wafers physical properties |
| Sweep -- Site | used to modify sweep parameters for Site tests |
| Sweep -- Gate Tox | used to modify sweep parameters for Gate Tox tests |
| Sweep -- Map | used to modify sweep parameters for Map tests |
| Probe Configuration | used to modify the probe configuration. Enables the engineer to choose between increased accuracy or increased throughput. |
| Stage Configuration | used to alter stage performance by modifying the stage’s motion, speed, and delay time between measurements. |

### Help Menu

The Help menu provides access to online help and the software version number.

## Toolbar

When the toolbar selection is activated in the View menu, twelve buttons are displayed below the main menu. These buttons give quick access to the following Recipe Builder features.

| | | |
|---|---|---|
| 🗋 | New | clears the entries in the Recipe Builder so that a new recipe can be defined |
| 📂 | Open | opens an existing recipe |
| 💾 | Save | saves the current test |
| ✂ | Cut | (disabled) |
| ⎘ | Copy | (disabled) |
| 📋 | Paste | (disabled) |
| 🖨 | Print | (disabled) |
| ? | About | reports installed version of Recipe Builder |

| | |
|---|---|
| Site Tests | displays the Site Plan |
| Map Tests | displays the Map Plan |
| Advanced Features | activates the Advanced Mode. |

The bottom of the Recipe Builder window displays a data field and two buttons:

> Estimated Completion Time: the estimated time required to complete the selected test (hours:minutes:seconds). Actual test times vary, based on the quality of the device being tested (poor quality materials can increase test times). The software updates the display as the user selects tests and test sites.
>
> Back: displays the previous screen in the sequence of active screens.
>
> Next: proceeds to the next active screen in the sequence of screens.

## Site and Map Plans

The Recipe Builder has two types of measurement (*plans*):

- Site Plan, for defining tests performed on specific sites on the wafer.
- Map Plan, for defining tests performed on a defined area of the wafer.

A single recipe can include both Site and Map tests. The user switches between the Site Plan and Map Plan by selecting the plan from the View menu or by clicking its icon in the toolbar.

The test plan records the tests selected for the measurement type. Testing options vary, depending on the test plan selected. Individual pages within the test plans are used to record parameters for each test. The program automatically determines the proper order of tests. Map tests are performed before site tests to prevent charge biasing.

### Test selection

The upper section of the Site and Map Plans lists the available tests for the plan. Checking the box next to a test selects the test and activates the corresponding tabbed page. Tests for both plans have user-set limits for data values. These limits assure that data is reasonable and within a specified tolerance range.

In addition to test selection, the Site Plan is used to set three variables:

- Wafer type: used to identify the wafer type as P (doped with acceptor impurities) or N (doped with donor impurities).
- Wafer Size: used to specify the size of the wafer to be tested (100, 125, 150, 200, or 300 mm).

- Flatten Charge: when checked, the system removes the charge gradient prior to testing.

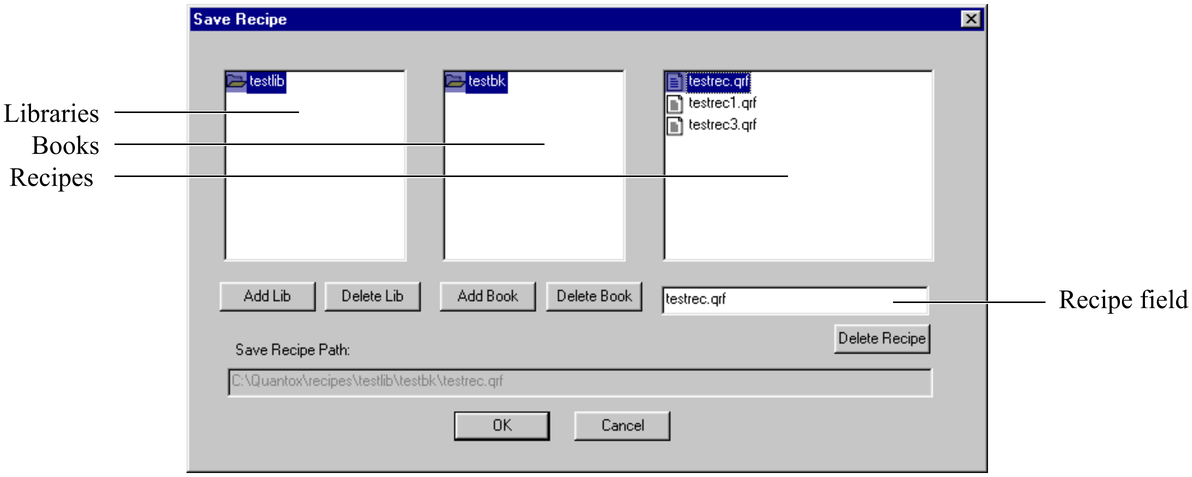
### Test description

The lower section of the Plan page records information used to describe the test. Optional information includes

- Process/Equipment being tested: the process/equipment name. You can enter up to 64 characters in the name.
- Database Name: the database to which the test data are written. The destination database can be selected from the drop-down list or by clicking the Browse button. Alternately, a new database can be created by entering a new database name in the Database Name field.
- Comments: can be up to 64 KB long. Entries can help other engineers build related recipes or help operators follow the best procedures for particular wafers or conditions.
- Keywords: associated with the test, keywords can be used in searches to find related recipes. Keywords can be up to 64 characters long.
- Export to Films Database: checking this box directs the software to export measurement data to a common database, thus enabling the data to be merged with data from other systems, both of the same product family and different product families.

## Recipe Directory

When the user selects Save or Save As, the Save Recipe window opens (Figure 2-6). This window shows the Quantox hierarchical recipe directory structure. Recipes are contained in Books, and Books are contained in Libraries. The window contains a field for entering a recipe name, and buttons for adding or deleting libraries and books.



testrec.qrf

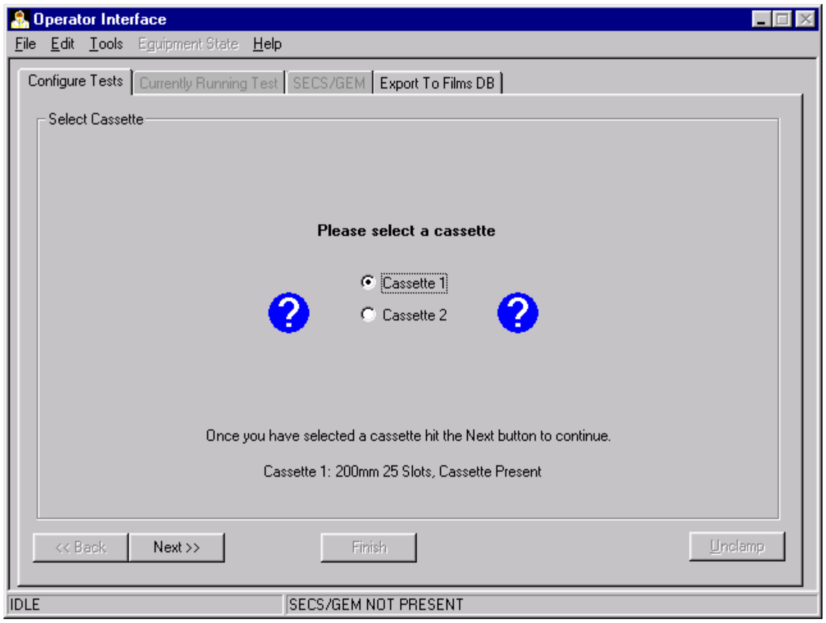
Save Recipe Path: C:\Quantox\recipes\testlib\testbk\testrec.qrf

**Figure 2-6**: Save Recipe Window

# Quantox Operator Interface

The Quantox Operator Interface (QOI) program (Figure 2-7) enables the user to select the test environment and control the test process. The program minimizes the number of operator-initiated test variables and provides the appropriate prompts for each of the actions the operator needs to perform.

After the operator selects a cassette, the robot arm uses a laser to scan the cassette and determine which slots contain wafers. A series of Windows enable the operator to confirm the wafer selection, choose a recipe, and initiate the test. All testing occurs automatically.



**Please select a cassette**

● Cassette 1
○ Cassette 2

Once you have selected a cassette hit the Next button to continue.

Cassette 1: 200mm 25 Slots, Cassette Present

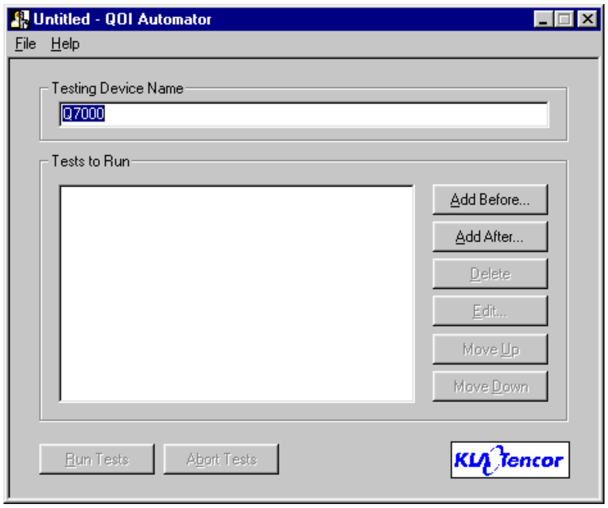
IDLE | SECS/GEM NOT PRESENT

**Figure 2-7**: Operator Interface Window

After the Quantox system completes a test run, the test data is broken down and saved in test information tables in the Quantox database. Each database table uses a key piece of test information, such as testrun_id, as the basis for the separate databases.

# Quantox Operator Interface Automator

The Quantox Operator Interface (QOI) Automator program (Figure 2-8) simulates the actions of an operator running tests from the Quantox Operator Interface, thus enabling the user to run a series of tests automatically.



Testing Device Name: Q7000

**Figure 2-8**: QOI Automator Main Window

Fields include

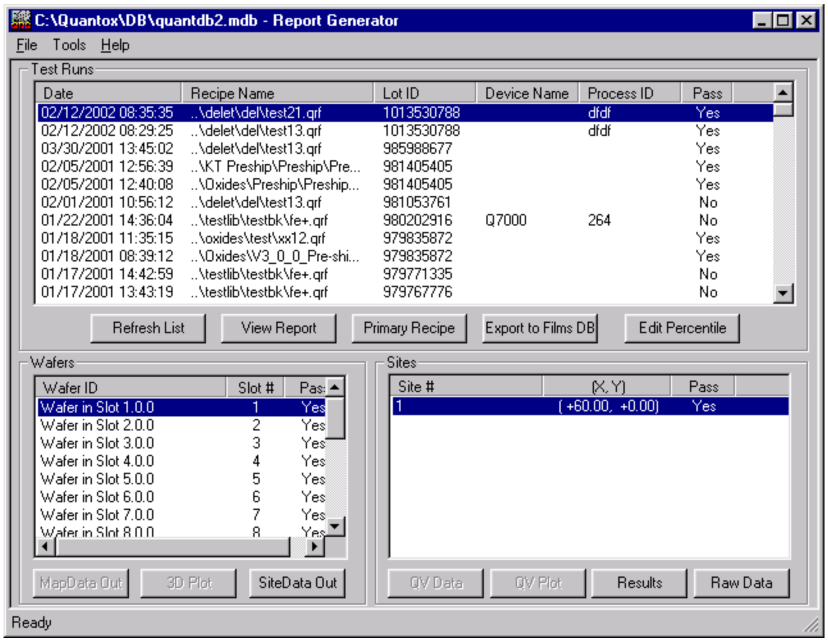
- Testing Device Name: by default, the Quantox tool's serial number. The name can be changed by typing a new name in the field. The Testing Device Name is used to identify the tool in generated test reports.
- Tests to Run: displays selected tests by Lot ID.

Buttons include

- Add Before: adds a test before the selected recipe
- Add After: adds a test after the selected recipe
- Delete: deletes the selected test
- Edit: edits information describing the selected test (Lot ID, Process ID, test repetition, wafer selection).
- Move Up: moves the test up in testing sequence
- Move Down: moves the test down in testing sequence.

# Quantox Report Generator

The Quantox Report Generator (QRG) program (Figure 2-9) enables the user to retrieve information stored in the database and display it in a format specified by the user.



| Date | Recipe Name | Lot ID | Device Name | Process ID | Pass |
|---|---|---|---|---|---|
| 02/12/2002 08:35:35 | ..\delet\del\test21.qrf | 1013530788 | | dfdf | Yes |
| 02/12/2002 08:29:25 | ..\delet\del\test13.qrf | 1013530788 | | dfdf | Yes |
| 03/30/2001 13:45:02 | ..\delet\del\test13.qrf | 985988677 | | | Yes |
| 02/05/2001 12:56:39 | ..\KT Preship\Preship\Pre... | 981405405 | | | Yes |
| 02/05/2001 12:40:08 | ..\Oxides\Preship\Preship... | 981405405 | | | Yes |
| 02/01/2001 10:56:12 | ..\delet\del\test13.qrf | 981053761 | | | No |
| 01/22/2001 14:36:04 | ..\testlib\testbk\fe+.qrf | 980202916 | Q7000 | 264 | No |
| 01/18/2001 11:35:15 | ..\oxides\test\xx12.qrf | 979835872 | | | Yes |
| 01/18/2001 08:39:12 | ..\Oxides\V3_0_0_Pre-shi... | 979835872 | | | Yes |
| 01/17/2001 14:42:59 | ..\testlib\testbk\fe+.qrf | 979771335 | | | No |
| 01/17/2001 13:43:19 | ..\testlib\testbk\fe+.qrf | 979767776 | | | No |

| Wafer ID | Slot # | Pas: |
|---|---|---|
| Wafer in Slot 1.0.0 | 1 | Yes |
| Wafer in Slot 2.0.0 | 2 | Yes |
| Wafer in Slot 3.0.0 | 3 | Yes |
| Wafer in Slot 4.0.0 | 4 | Yes |
| Wafer in Slot 5.0.0 | 5 | Yes |
| Wafer in Slot 6.0.0 | 6 | Yes |
| Wafer in Slot 7.0.0 | 7 | Yes |
| Wafer in Slot 8.0.0 | 8 | Yes |

| Site # | (X, Y) | Pass |
|---|---|---|
| 1 | ( +60.00, +0.00) | Yes |

**Figure 2-9**: Report Generator

The main window in the Report Generator is divided into three parts:

- Test Runs: lists all the test runs performed
- Wafers: lists all wafers in the selected test run
- Sites: lists all test sites on the selected wafer.

Test Runs buttons include

- Refresh List: rescans the database and updates the Test Runs window to include any tests run since the Report Generator was opened.
- View Report: generates and displays a report of the selected test run.
- Primary Recipe: describes the recipe used for the selected test run.
- Export to Films DB: exports data from the Quantox database to the Common Database.
- Edit Percentile: enables you to modify the user-defined percentiles. Edited percentiles do not change any recipe-defined percentiles, nor do they

change any data in the Quantox database. Edit Percentile is enabled only for map data.

Wafers buttons include

- MapData Out: displays the map data for the selected wafer.
- 3D Plot: renders the map data in a three-dimensional view
- SiteData Out: displays the site information for the wafer.

Sites buttons include

- QV Data: displays QV data for the selected site.
- QB Plot: plots QV data as specified by the user.
- Results: displays individual test information for the selected site
- View Raw Data: provides access to raw data.

## Tools

The Tools Menu in the Report Generator includes

- Subtraction report: enables the user to obtain a subtraction report comparing the results of two tests. Test runs must be identical for wafer ID, number of wafers, number and location of sites, map type and size, and test type.
- Header configuration (Tools | Options): enables the user to modify the headers displayed in the Operator Interface and included in Quantox reports.
- Automation configuration (Tools | Options): enables the user to request confirmation of host start and to set password requirements.
- FFU configuration (Tools | Options): enables the user to configure the system’s response to a Filter Fan Unit alarm.

# Quantox Data Wizard

Quantox Data Wizard (Figure 2-10) provides a means to view repeatability graphs using the Quantox database. A plug-in to Microsoft Excel, Data Wizard is accessed from within Excel.

A configuration option provides control over the format of the charts produced. Multiple chart descriptions can be created. For example, one chart description could be formatted for paper output while another could be formatted for transparencies.

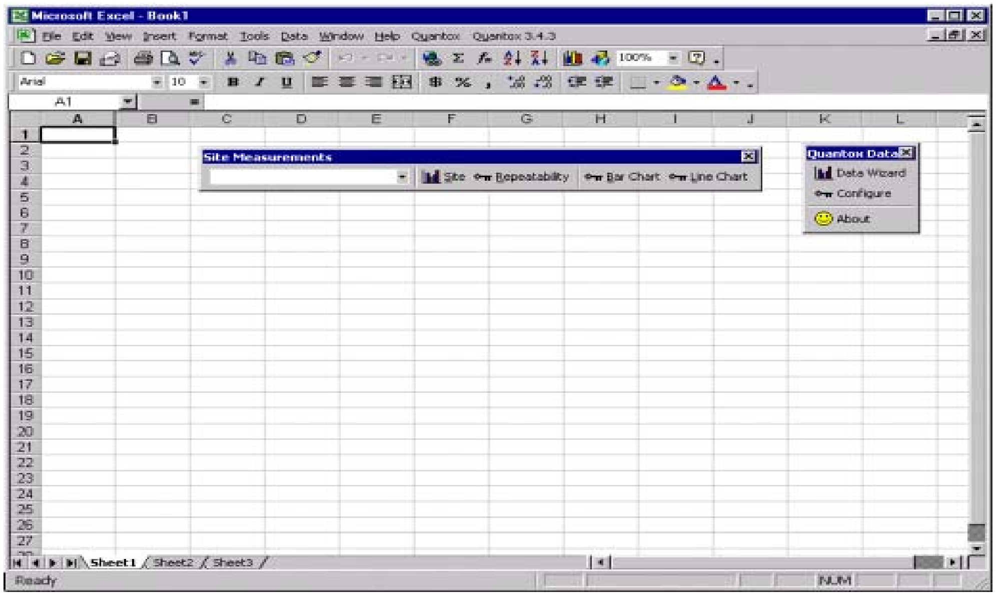


**Figure 2-10**: Quantox Data Wizard

**NOTE**

Two versions of Data Wizard are provided in the Data Wizard Menu bar:

- version 3.1.2 (Quantox) for databases from Quantox software versions prior to 3.4.3
- version 3.4.3 (Quantox 3.4.3) for databases from Quantox software versions 3.4.3 and later

# ARAMS

The Automated Reliability, Availability and Maintainability Standard (ARAMS) is a system for monitoring equipment states. ARAMS enables tracking or selection of the following six equipment states:

- Standby
- Productive
- Scheduled Downtime
- Unscheduled Downtime
- Engineering
- Non Scheduled Time

As a part of ARAMS, Quantox systems include a database (QE10DB) and two applications (QE 10 and QE 10 Report Generator) to support the SEMI 10 specification.

## QE 10

QE 10 logs the following data into the QE 10DB database:

- Assists and failures
- Site, wafer, and lot cycles
- The six equipment states listed in the previous paragraph

## QE 10 Report Generator

This application uses the data logged by QE 10 to perform the reliability measurements specified by SEMI 10. QE 10 Report Generator can select any E 10 database, calculate any E 10 measurements, and print, save, and open reports.

# Chapter 3
# Quantox Recipe Builder

A Quantox recipe is a user-generated file of test setup parameters. When run on the Quantox system, the recipe directs the system to perform a series of predefined wafer tests. The Quantox Recipe Builder (QRB) program enables a test engineer to design custom recipes for different types of wafers, for product or process development, and for specific fab circumstances. These recipes enable the system to quickly adapt to a complex testing environment. Over time, a fab can develop many recipes to provide the right tests for each situation.

This chapter describes

# Starting the Recipe Builder

After logging on to the system and running the Quantox Startup program (described in Chapter 2) start the Recipe Builder from the Windows NT Start menu by selecting Programs | Quantox | Recipe Builder. The system opens the Recipe Builder window with the Site Plan selected.

The Recipe Builder provides two measurement plans:

- The Site Plan (Figure 3-1) is used to define tests that measure individual sites on the wafer (site tests).
- The Map Plan (Figure 3-2) is used to define tests that measure a specific area of the wafer (map tests).

# Building Recipes

Building a recipe involves

- Setting Recipe parameters: wafer description, sweep control, probe and stage configurations.
- Defining the test plan(s)
- Setting up the selected tests
- Defining an additional set of percentile values at which to report map test data[1]
- Saving the recipe

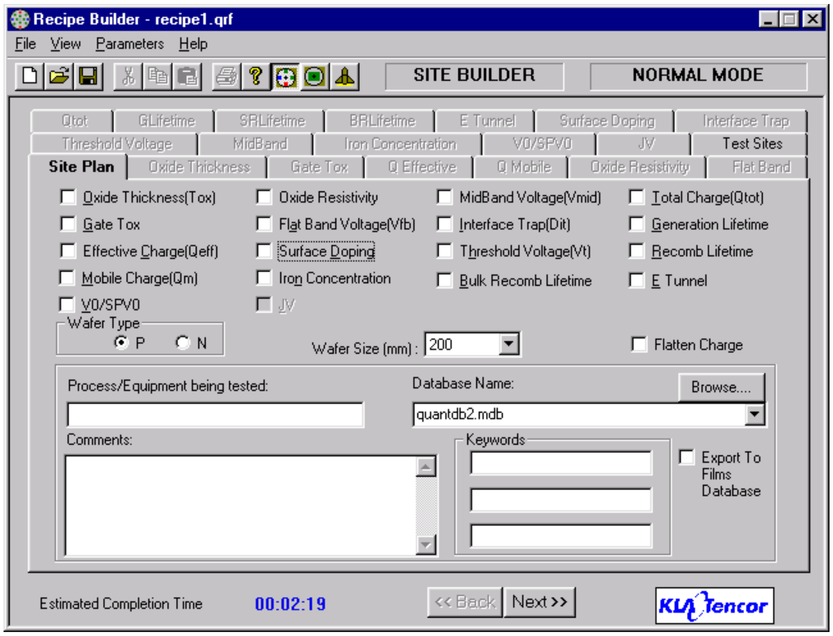
**NOTE**

Depending on production requirements, a single recipe can include Site tests, Map tests or a combination of both. When a single recipe includes both Site and Map tests, Map tests are performed before Site test to prevent charge biasing. Site and map tests are described on page 3-29.

Because production environments have time limits on equipment usage, engineers should limit tests and test sites to the minimum necessary to answer their production concerns. KLA-Tencor applications engineers can provide advice on the appropriate use of tests.

---

[1] Lot statistics for maps currently displayed in QRG and Data Wizard is limited to 10%, 50%, and 90%. The ability to define an additional set of percentile values enables more effective use of map results.

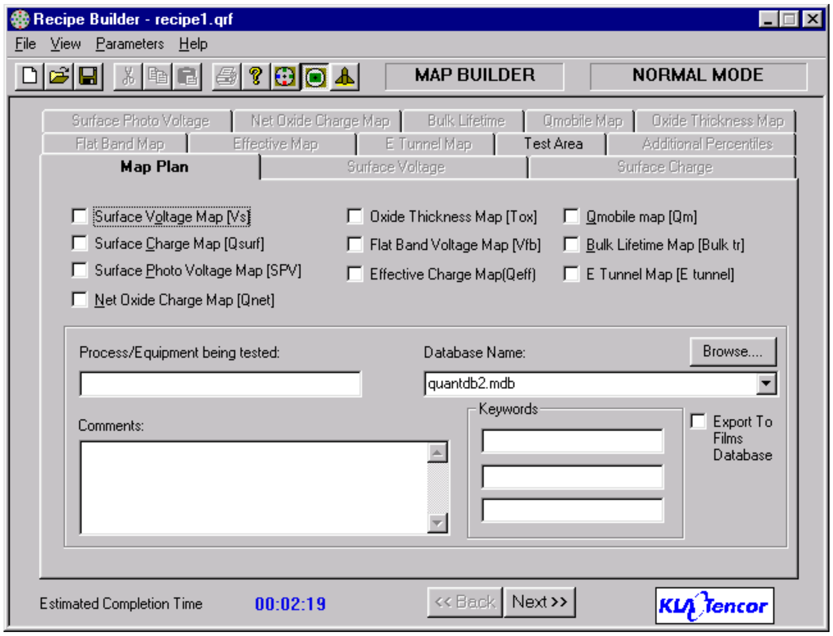


Wafer Size (mm) : 200

Database Name: quantdb2.mdb

Estimated Completion Time 00:02:19

**Figure 3-1**: Recipe Builder, Site Plan



Database Name: quantdb2.mdb

Estimated Completion Time 00:02:19

**Figure 3-2**: Recipe Builder, Map Plan

# Setting Recipe Parameters

Recipe Parameters settings are based on a thorough knowledge of the properties of the wafer and the test environment. The Parameters Menu (Figure 3-3) comprises

- Wafer Description, for recording the physical characteristics of the wafer.
- Sweep Controls, for modifying the Site, Gate $T_{ox}$, and Map Sweep parameters for QV measurements.
- Probe Configuration, for controlling the Kelvin probes
- Stage Configuration, for controlling the stage performance

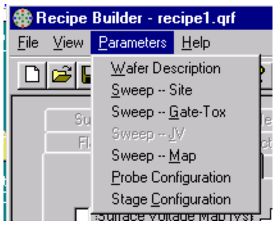
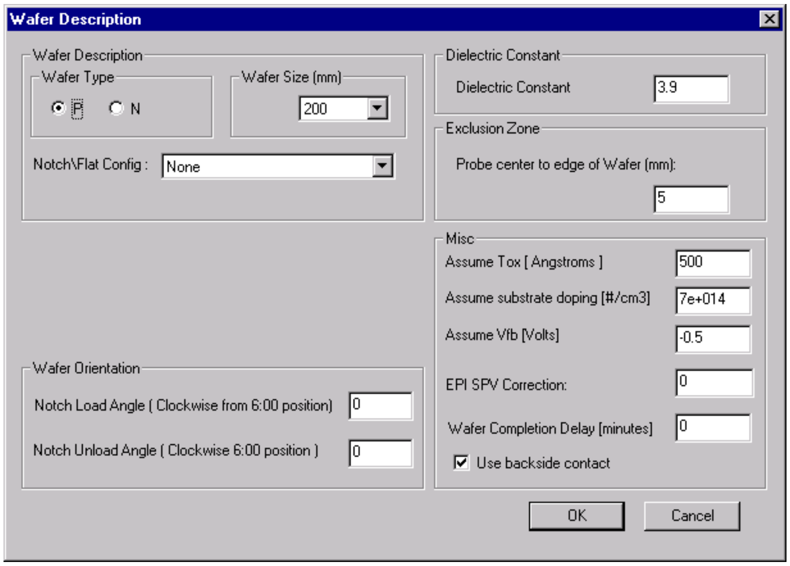


**Figure 3-3**: Parameters Menu

## Wafer Description

Wafer Description (Figure 3-4) is used to provide the system with a physical description of the wafer including material type, dielectric constant, wafer size, orientation (200- and 300-mm wafers only), and location indicators. An Exclusion Zone parameter defines the setback from the wafer's edge (edge exclusion) that should be observed for both site-based tests and wafer maps.

The Wafer Description window also allows for the entry of oxide thickness, substrate doping, and flatband voltage values, as well as use of an EPI SPV correction factor, a wafer completion delay, and the backside contact.



Wafer Description

Wafer Type: ● P ○ N

Wafer Size (mm): 200

Notch\Flat Config : None

Dielectric Constant

Dielectric Constant: 3.9

Exclusion Zone

Probe center to edge of Wafer (mm): 5

Misc

Assume Tox [ Angstroms ]: 500

Assume substrate doping [#/cm3]: 7e+014

Assume Vfb [Volts]: -0.5

EPI SPV Correction: 0

Wafer Completion Delay [minutes]: 0

☑ Use backside contact

Wafer Orientation

Notch Load Angle ( Clockwise from 6:00 position): 0

Notch Unload Angle ( Clockwise 6:00 position ): 0

**Figure 3-4**: Wafer Description Parameters

---

**NOTE**

Several of the fields in this window (such as Wafer Type, Dielectric Constant, Assume $T_{ox}$) are linked to fields in the individual test setup. Changes in one instance of these fields are reflected in the others.

If you change the values for Wafer Size or Exclusion Zone after selecting test sites or a test area (as you might do when adapting a 200-mm wafer recipe for use on 300-mm wafers) the test site or area selections are no longer valid. You then need to return to the Test Plan or Map Plan and reselect the test sites or area.

---

## Sweep Control

Under normal testing, the sweep is controlled by the system (Auto Sweep Mode). For specific instances when the Auto Sweep Mode does not capture the portion of the sweep that is of interest, the Parameters Menu enables manual control.

---

**CAUTION**

Manual Mode should ***only*** be used for QV tests (such as $V_{fb}$, $D_{it}$, $T_{ox}$) and is not recommended for daily process monitoring. Contact your KLA-Tencor Applications Engineer for assistance when modifying Sweep Controls.

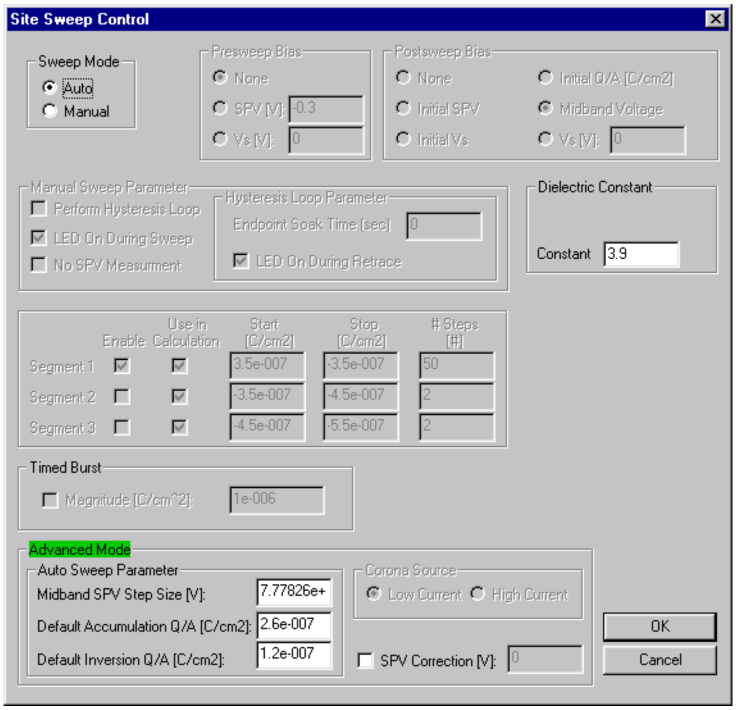
---

Sweep Controls include

- Site Sweep
- Gate $T_{ox}$ Sweep
- Map Sweep

### Site Sweep Control

Figure 3-5 shows the Site Sweep Control. Table 3-1 describes the control parameters. (Advanced Mode is activated by clicking the Advanced Features button in the toolbar before opening this window.)



Sweep Mode: ● Auto ○ Manual

Presweep Bias: ● None ○ SPV [V]: -0.3 ○ Vs [V]: 0

Postsweep Bias: ○ None ○ Initial SPV ○ Initial Vs ○ Initial Q/A [C/cm2] ● Midband Voltage ○ Vs [V]: 0

Manual Sweep Parameter: ☐ Perform Hysteresis Loop ☑ LED On During Sweep ☐ No SPV Measurement

Hysteresis Loop Parameter: Endpoint Soak Time (sec) 0 ☑ LED On During Retrace

Dielectric Constant: Constant 3.9

| | Enable | Use in Calculation | Start [C/cm2] | Stop [C/cm2] | # Steps [#] |
|---|---|---|---|---|---|
| Segment 1 | ☑ | ☑ | 3.5e-007 | -3.5e-007 | 50 |
| Segment 2 | ☐ | ☑ | -3.5e-007 | -4.5e-007 | 2 |
| Segment 3 | ☐ | ☑ | -4.5e-007 | -5.5e-007 | 2 |

Timed Burst: ☐ Magnitude [C/cm^2]: 1e-006

Advanced Mode

Auto Sweep Parameter:
Midband SPV Step Size [V]: 7.77826e+
Default Accumulation Q/A [C/cm2]: 2.6e-007
Default Inversion Q/A [C/cm2]: 1.2e-007

Corona Source: ● Low Current ○ High Current

☐ SPV Correction [V]: 0

**Figure 3-5**: Site Sweep Control, Advanced Mode

**Table 3-1**: Site Sweep Control Parameters

| Parameter | Options | Description |
|---|---|---|
| Sweep Mode | Auto | The default. |
| | Manual | Manual Mode enables modification of sweep parameters but should only be used when recommended by your KLA-Tencor Applications Engineer. |

**Table 3-1**: Site Sweep Control Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Presweep Bias<br>(Manual Mode) | | Presweep Bias sets the sweep to a starting point of the sweep. If other measurements have been done on the sites in the recipe, or if there is residual charge on the surface of the oxide, a presweep bias might be required. |
| | None | The default. No presweep bias used. |
| | SPV (V) | Uses the surface photovoltage as the starting point |
| | $V_s$ (V) | Uses the surface voltage value as the starting point. |
| Postsweep Bias<br>(Manual Mode) | | Postsweep bias is used to set up a flat charge region after the completion of one test and before the start of another. |
| | None | No postsweep bias used. |
| | Initial SPV | Sets the site to the initial surface photovoltage. |
| | Initial $V_s$ | Sets the site to the initial surface voltage. |
| | Initial Q/A (C/cm$^2$) | The default. Sets the site to the charge that was on the wafer before the start of the first test. |
| | Midband Voltage | Sets the site to the midband or midgap in depletion on the site. If midgap is not found, the site is set to the midpoint of the sweep. |
| | $V_s$ (V) | Allows the user to set the site to any voltage.<br>This setting can be used to stress sites or a specific oxide using a heat treatment with the Quantox oven, or to set sites to a voltage to be used on subsequent measurements. |

**Table 3-1**: Site Sweep Control Parameters (Continued)

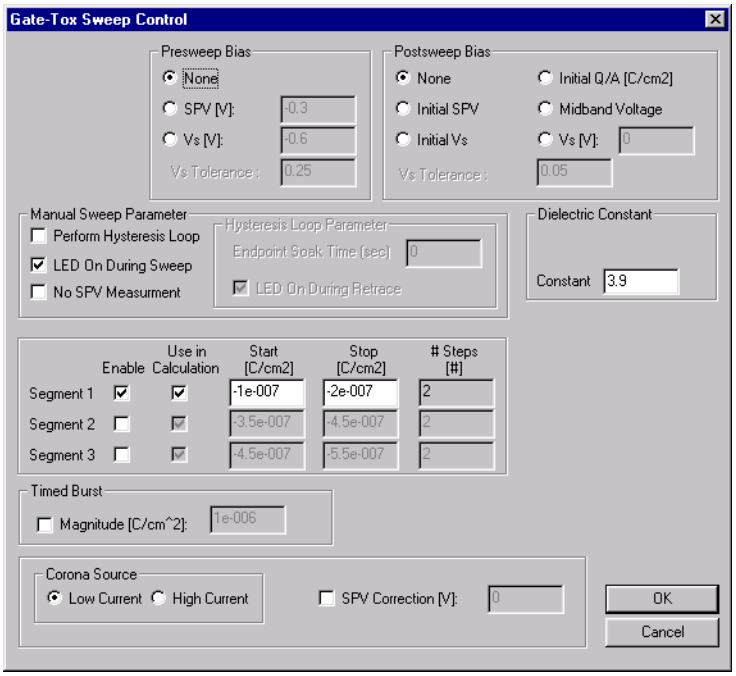
| Parameter | Options | Description |
|---|---|---|
| Manual Sweep Parameters<br>(Manual Mode) | Perform Hysteresis Loop | Activating the hysteresis loop retraces the sweep back in the opposite direction after a soak period.<br>Hysteresis tests are used to find slow traps at the silicon/oxide interface. Data can be analyzed by looking at V-SPV plot data in the Report Generator or by using the Quantox Data Wizard and comparing V-SPV curves using the Advanced Features option. A hysteresis in the data indicates if slow traps are active in the oxide. |
| | LED On During Sweep | Ensures that the sweep in inversion does not go into deep depletion after charge is generated on the site. To ensure that the SPV plot looks normal in inversion, the LED should be on.<br>The default is ON. |
| | No SPV Measurement | The SPV can be turned off to gain only QV trace. QV-only traces only generate $D_{it}$ and $T_{ox}$ measurements. |
| Dielectric Constant | user-defined | The dielectric constant of the dielectric film can be changed to any dielectric film or constant. |
| (Manual Mode sweep setup) | user-defined | Allows the user to set up the sweep in any direction, from inversion to accumulation or accumulation to inversion.<br>• Clicking the Enable box enables the sweep.<br>• Clicking the Use in Calculation box enables parameter extraction from this section of the raw data.<br>The default parameters for the Start and Stop of the sweep are standard for the Auto Sweep Mode. The maximum and minimum charges are +/– 2.0E-5.0 (C/cm$^2$). |

**Table 3-1**: Site Sweep Control Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Timed Burst<br>(Manual Mode) | Magnitude ($C/cm^2$) | |
| Corona Source (Manual Mode / Advanced Mode) | Low Current | Low Current Source (the default) is optimized for accurate Q-V analysis. |
| | High Current | High Current Source provides quicker biasing, but it is less uniform and therefore less suitable for high-precision $D_{it}$, $V_{fb}$, etc., measurements. |
| SPV Correction (Advanced Mode) | user-defined | Used to set an SPV offset. Typically used when the wafer is not bulk silicon and has an epilayer or $V_t$ implant.<br>During a standard Autosweep measurement, SPV must cross the SPV = 0 line on an SPV plot. If SPV does not cross 0, but the plot looks normal, no QV parameters can be calculated. The SPV correction can be used to get SPV to cross the SPV = 0 line. |

## Gate $T_{ox}$ Sweep

Figure 3-6 shows the Gate $T_{ox}$ Sweep Control. The parameters for a Gate $T_{ox}$ Sweep are similar to those of the Manual Sweep for site-based measurements (Table 3-1). For Gate $T_{ox}$ measurements, the two data points should be obtained out in accumulation, in a region fairly far away from $V_{fb}$ (typically at 1 to 2 MV/cm applied field).



Gate-Tox Sweep Control

Presweep Bias
● None
○ SPV [V]: -0.3
○ Vs [V]: -0.6
Vs Tolerance : 0.25

Postsweep Bias
● None
○ Initial SPV
○ Initial Vs
○ Initial Q/A [C/cm2]
○ Midband Voltage
○ Vs [V]: 0
Vs Tolerance : 0.05

Manual Sweep Parameter
☐ Perform Hysteresis Loop
☑ LED On During Sweep
☐ No SPV Measurment

Hysteresis Loop Parameter
Endpoint Soak Time (sec) 0
☑ LED On During Retrace

Dielectric Constant
Constant 3.9

| | Enable | Use in Calculation | Start [C/cm2] | Stop [C/cm2] | # Steps [#] |
|---|---|---|---|---|---|
| Segment 1 | ☑ | ☑ | -1e-007 | -2e-007 | 2 |
| Segment 2 | ☐ | ☑ | -3.5e-007 | -4.5e-007 | 2 |
| Segment 3 | ☐ | ☑ | -4.5e-007 | -5.5e-007 | 2 |

Timed Burst
☐ Magnitude [C/cm^2]: 1e-006

Corona Source
● Low Current ○ High Current

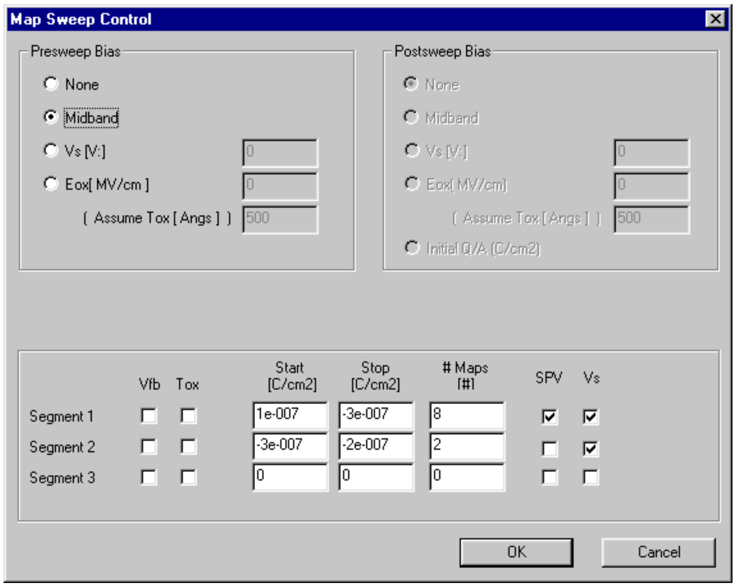
☐ SPV Correction [V]: 0

**Figure 3-6**: Gate $T_{ox}$ Sweep Control

### Map Sweep

Figure 3-7 shows the Map Sweep Control. The Manual Map Sweep function for maps emulates the Site Sweep function, however the Map Sweep employs the Blanket Charge to apply a bias to the entire wafer and calculates the amount of charge to apply and where to apply it.

The Manual Map Sweep function allows for the pre-and post-biasing options as well as for the iterations required to perform a sweep (see Table 3-1). If the user selects $E_{ox}$, a reasonable guess for $T_{ox}$ is helpful. However, on the second charge step, the Quantox system uses its own calculated value for $T_{ox}$.



Presweep Bias

- ○ None
- ● Midband
- ○ Vs [V:] 0
- ○ Eox[ MV/cm ] 0
- ( Assume Tox [ Angs ] ) 500

Postsweep Bias

- ● None
- ○ Midband
- ○ Vs [V:] 0
- ○ Eox[ MV/cm] 0
- ( Assume Tox [ Angs ] ) 500
- ○ Initial Q/A (C/cm2)

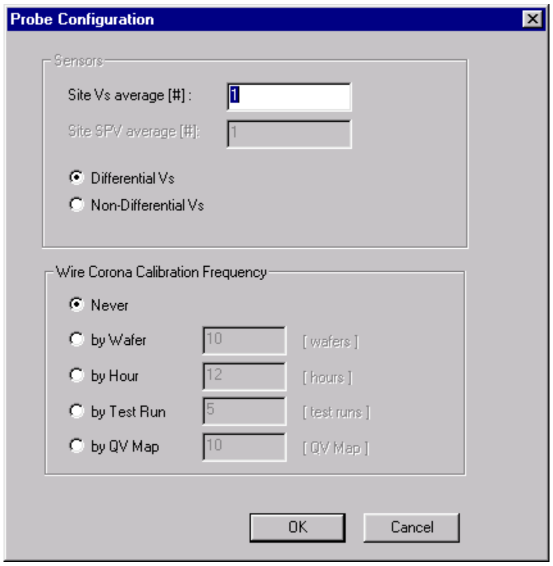
|  | Vfb | Tox | Start [C/cm2] | Stop [C/cm2] | # Maps [#] | SPV | Vs |
|---|---|---|---|---|---|---|---|
| Segment 1 | ☐ | ☐ | 1e-007 | -3e-007 | 8 | ☑ | ☑ |
| Segment 2 | ☐ | ☐ | -3e-007 | -2e-007 | 2 | ☐ | ☑ |
| Segment 3 | ☐ | ☐ | 0 | 0 | 0 | ☐ | ☐ |

**Figure 3-7**: Map Sweep Control

## Probe Configuration

The Probe Configuration function (Figure 3-8) provides the advanced user with greater control over the measurement Kelvin probes. The options enable the user to choose between increased accuracy or increased throughput.

Figure 3-8 shows the Probe Configuration window. Table 3-2 describes the configuration parameters.



Probe Configuration

Sensors

Site Vs average [#] : 1

Site SPV average [#]: 1

● Differential Vs

○ Non-Differential Vs

Wire Corona Calibration Frequency

● Never

○ by Wafer 10 [ wafers ]

○ by Hour 12 [ hours ]

○ by Test Run 5 [ test runs ]

○ by QV Map 10 [ QV Map ]

**Figure 3-8**: Probe Configuration

---

**CAUTION**

The measurement mode should be set to Differential $V_s$ for all recipes unless specific instructions are received from the KLA-Tencor Applications group.

---

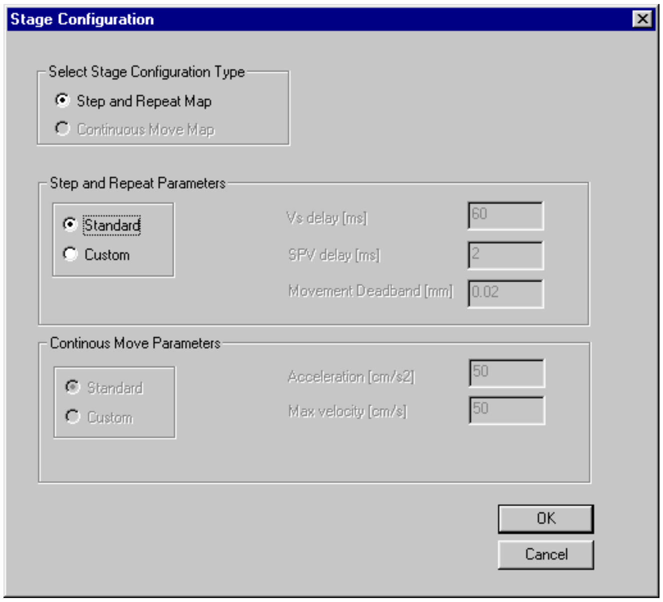
**Table 3-2**: Probe Configuration Parameters

| Parameter | Option | Description |
|---|---|---|
| Site $V_s$ average [#] | user-defined | Indicates how many voltage measurements should be made. The number is then used in calculating the average. This configuration is used only during site-based measurements. Typically only needed on ultrathin (<20Å) gate dielectrics. |
| (measurement mode) | Differential $V_s$<br>Non-Differential $V_s$ | Mode selection is intended to minimize the noise level from the Kelvin probes, thus optimizing the accuracy of the measurement.<br>Mode selection is made based on a knowledge of the type of measurement to be made:<br>• $T_{ox}$, $D_{it}$, $\rho_{ox}$ (oxide resistivity), Doping, and Lifetimes are Differential measurements.<br>• $V_s$ and $V_{fb}$ are Non-Differential or Direct measurements.<br>Differential $V_s$ is the default. |
| Wire Corona Calibration Frequency | Never<br>by Wafer<br>by Hour<br>by Test Run<br>by QV Map | Directs the system to calibrate the wire source at specified interval.<br>Unlike the needle-corona source, the wire source does not have an automatic self-calibration during corona deposition. The wire source should be calibrated often (typically every 12 hours), but the frequency of the calibration depends on the individual Fab requirement.<br>The default is Never. Check with KLA-Tencor Applications or Field Service representative prior to enabling this automatic calibration feature. |

## Stage Configuration

The Stage Configuration function allows you to control stage performance by controlling the stage’s motion, speed, and delay time between measurements. The selection of stage parameters can enable the user to increase the measurement throughput, but it can also decrease the sensitivity and accuracy of the measurement.

Figure 3-9 shows the Stage Configuration window. Table 3-3 describes the configuration parameters.



Stage Configuration

Select Stage Configuration Type
- ● Step and Repeat Map
- ○ Continuous Move Map

Step and Repeat Parameters
- ● Standard
- ○ Custom

Vs delay [ms] 60
SPV delay [ms] 2
Movement Deadband [mm] 0.02

Continous Move Parameters
- ● Standard
- ○ Custom

Acceleration [cm/s2] 50
Max velocity [cm/s] 50

**Figure 3-9**: Stage Configuration

---

**CAUTION**

Stage parameters should not be adjusted unless the stage appears to be noisy or slow. Adjustment of these parameters can have a ***direct*** impact on the measurement accuracy and repeatability. The parameters should only be adjusted by KLA-Tencor Field Service or Applications Engineers.

**Table 3-3**: Stage Configuration Parameters

| Parameter | Option | Description |
|---|---|---|
| Stage Configuration Type | Step and Repeat Map | System default setting |
| | Continuous Move Map | Allows the stage to move in a continuous motion with a well-defined radius and arc, similar to a spiral motion. This configuration tremendously increase the speed of the stage for QuickMap measurements. |
| Step and Repeat Parameters | Standard | System default setting |
| | Custom | Enables modification of Step and Repeat stage motion. The stage can be set for $V_s$ or SPV.<br>The Movement Deadband parameter identifies the X-Y range at which the stage is allowed to fluctuate before moving to the next coordinates. |
| Continuous Move Parameters | Standard | System default setting |
| | Custom | Enables modification of stage acceleration and maximum velocity for maps-based tests. |

# Defining a Test Plan

To define a test plan:

1. From within the Recipe Builder, choose the appropriate test plan (Site or Map) by selecting the plan from the View menu or by clicking its button in the toolbar (Figure 3-10 and Figure 3-11).
2. Select the desired test(s) by clicking the box next to the test(s). Individual tests are described later in this chapter:
   - The description of Site tests begins on page 3-32.
   - The description of Map tests begins on page 3-84.

   When a test is selected its tab is activated, and the Estimated Completion Time displayed at the bottom of the window increases to reflect the time required for the test.

**NOTE**

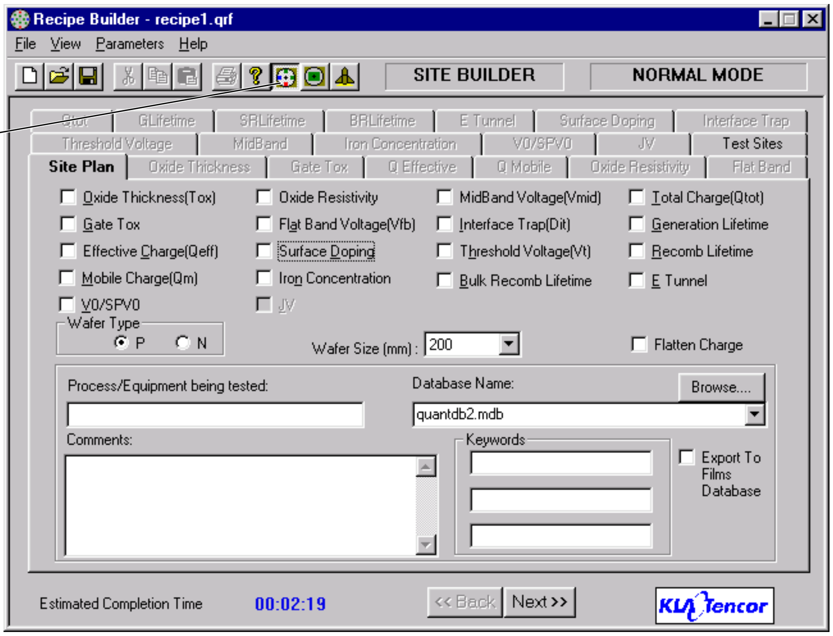
Depending upon the licensed options, certain measurement selections in the Site Plan and Map Plan might be grayed-out.

3. For site tests, select Wafer Type, Wafer Size, and Flatten Charge options (Table 3-4).
4. Select a destination database from the Database Name drop-down list or click the Browse button to choose a different location.

   To create a new database during execution, merely enter the new database name in the field. The new database is then created as a result of running the recipe.
5. Enter descriptive text in the Process/Equipment, Comments, and Keyword fields. These fields are common to the Test and Map plans, therefore entries for one plan are duplicated in the other.
6. When the test plan is completed, click the Next button to continue the test setup.

   The Recipe Builder displays the tabbed page for the first selected test.
7. Proceed to “Setting Up the Selected Tests” on page 3-20.

Site Plan button



Wafer Type: ● P ○ N

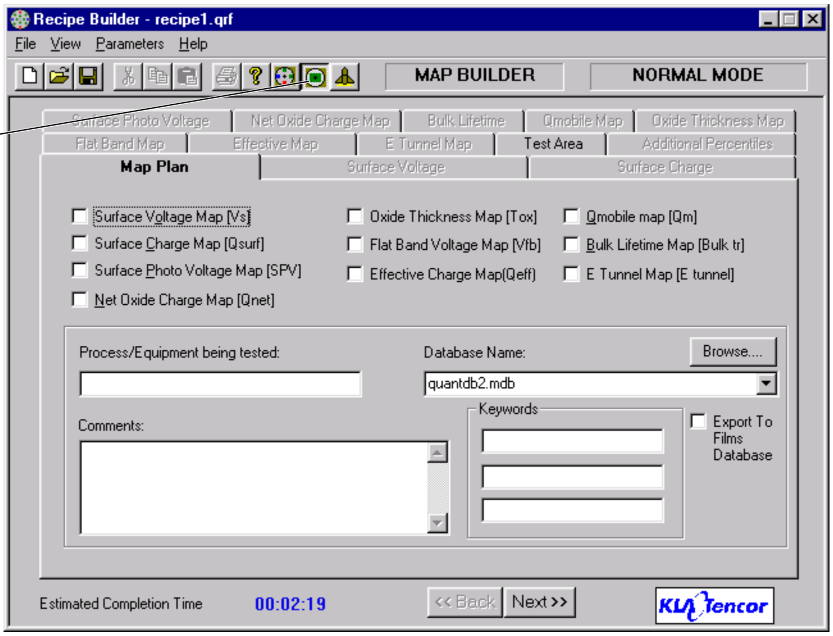
Wafer Size (mm) : 200

Database Name: quantdb2.mdb

Estimated Completion Time 00:02:19

**Figure 3-10**: Recipe Builder, Site Plan

Map Plan button



Database Name: quantdb2.mdb

Estimated Completion Time 00:02:19

**Figure 3-11**: Recipe Builder, Map Plan

**Table 3-4**: Plan Parameters

| Parameter | Options | Description |
|---|---|---|
| Wafer Type (Site plan only) | P, N | P-type is doped with acceptor impurities.<br>N-type is doped with donor impurities.<br>Can also be selected in the Wafer Description under the Parameters menu (changing the entry in one location also changes it in the other). |
| Wafer Size (Site plan only) | 100, 125, 150, 200, 300 mm | The diameter of the test wafer.<br>Can also be selected in the Wafer Description under the Parameters menu (changing the entry in one location also changes it in the other).<br>Changing the Wafer Size ***after*** selecting test sites invalidates the test sites. |
| Flatten Charge (Site plan only) | checked or not checked | When enabled (checked), the charge on the surface of the wafer is *flattened* before the site-based measurement is made.<br>The option should be enabled when measuring $V_{fb}$ or $D_{it}$ on a wafer with very high incoming gradients in charge or when repeatedly measuring the same site on a wafer. (Repeated testing can cause gradients in charge to build up on the wafer.)<br>The option has little effect on very thin oxides (under 100 Å) and can in fact result in apparent $D_{it}$ levels that are higher than those actually present.<br>The option should be disabled when measuring $Q_{tot}$.<br>This option adds a few extra minutes to measurement time. |
| Process / Equipment being tested | user defined | Used to provide a description of the process or equipment being tested. The number of characters is limited to the size of text field. |
| Database Name | user defined | The database to which the test data is written.<br>The destination database can be selected from the drop-down list or by clicking the Browse button. Alternately, a new database can be created by entering a new database name in the Database Name field. |

**Table 3-4**: Plan Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Comments | user defined | Used to convey information about the recipe setup or best practices for particular wafers or conditions. Comments can be up to 64 KB. |
| Keywords | user defined | Accepts three keywords, each up to 64 characters long. |
| Export to Films Database | selected or not selected | Directs the software to export measurement data to a common database. This enables the test data to be merged with data from other systems, both of the same product family and different product families. |

# Setting Up the Selected Tests

Test parameters vary depending on the selected test. Some tests only require entry of Data Value Limits, while other tests offer Advanced Feature options to provide greater control over the testing process. Site and Map tests are set up in a similar manner.

To set up a test:

1. Referring to the test descriptions beginning on page 3-29, enter the appropriate parameter values for the selected test.

   To use the Advanced Mode, click the Advanced Features button in the toolbar and define the additional parameters.

2. In the Test Limits portion of the page, enter the desired data value limits for the test (Table 3-5.). Make sure the limits are within the range stated in the process specification.

3. When entries for the test type are completed, click the Next button and repeat these steps to set up the next test.

   When all tests are set up, the Next button displays Test Sites tab (for site-based tests) or Test Area tab (for map-based tests). Proceed to the appropriate section for a description of site or area selection:

   – For Test Sites, proceed to "Selecting Test Sites" on page 3-21

   – For Test Area, proceed to "Selecting a Test Area" on page 3-23.

**Table 3-5**: Data Value Limits

| Limit | Value | Description |
|---|---|---|
| Engineering | user-defined,<br>units vary with test type | Normally associated with engineering and research tests. These limits are the most restrictive. Engineering limits test the wafers and the effects of related equipment and processes. Wafers testing within engineering limits are also acceptable for production. |
| Production | user-defined,<br>units vary with test type | Normally associated with production units. Units that measure within these limits are considered acceptable for production. Production limits are more restrictive than the valid limits but less restrictive than engineering limits. |
| Valid | fixed in the software,<br>units vary with test type | Have the widest tolerance. Outside these limits, data is meaningless and unusable. |

# Selecting Test Sites

Test sites are the sites on the wafer that are tested using the Site Plan.

To select test sites:

1. Confirm that the wafer size displayed below the wafer graphic on the Test Sites Tab is correct (Figure 3-12).

   To change the wafer size or review other wafer parameters, select Wafer Description from the Parameters Menu (Figure 3-3).

---

**NOTE**

If you select test sites and later change the Wafer Size or Exclusion Zone, the test sites are no longer valid and are deleted.

---

2. Select the Snap to Grid option if you wish to place test sites between the lines of a wafer grid. Deselect the option if you wish to place sites at irregular intervals.
3. Select a test site by either:
   - Entering the site's coordinates in the Manual Site Entry fields.
   - Clicking on the desired site on the wafer graphic. As the cursor moves across the wafer, the X and Y coordinates below the graphic change to indicate the location of the site, relative to the center of the wafer (0, 0).

   To delete a site, double-click the site on the wafer graphic.

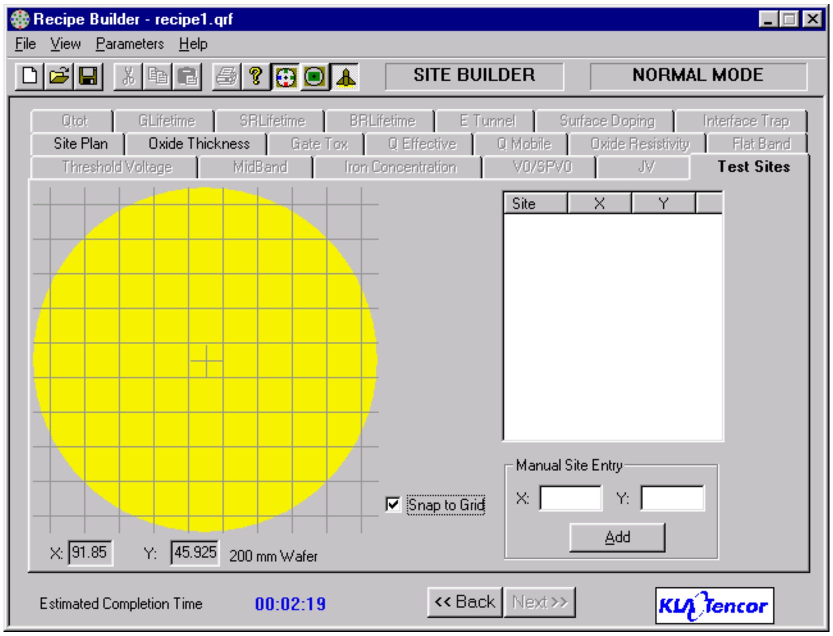
---

**NOTE**

Site coordinates must be at least 20 mm apart. As you select test sites, the coordinates of each site are displayed in a list to the right of the wafer graphic.

---

4. When you've finished selecting sites, you can click the Back button to review the Site tests.
5. When you've finished building the recipe, proceed to "Saving the Recipe" on page 3-27.



Recipe Builder - recipe1.qrf

☑ Snap to Grid

X: 91.85 Y: 45.925 200 mm Wafer

Estimated Completion Time 00:02:19

**Figure 3-12**: Test Sites

# Selecting a Test Area

The test area is the area of the wafer that is mapped using the tests selected in the Map Plan.

To select a test area:

1. Confirm that the wafer size displayed below the wafer graphic on the Test Area tab (Figure 3-13) is correct.

   To change the wafer size or review other wafer parameters, select Wafer Description from the Parameters Menu.

---

**NOTE**

If you select a test area and later change the Wafer Size or Exclusion Zone, the selected test area is no longer be valid and is deleted.

---

2. If you wish to test the entire wafer (within the exclusion zone), click the Full Wafer button and proceed to step 7. Otherwise, choose an Area Selection tool, by clicking the icon that represents the desired shape of the test area (circle or a rectangle) and continue on to step 3.
3. Move the cursor to the wafer graphic. As the cursor moves across the wafer, the X and Y coordinates below the graphic change to indicate the location of the cursor, relative to the center of the wafer (0, 0).
4. Place the cursor at the starting point for the desired test area:
   – For a circle, place the cursor at the center of test area.
   – For a rectangle, place the cursor at the upper left-hand corner of the test area.
   – To place the cursor at the center of the wafer graphic, click the Cursor To Center button.
5. Press down on the mouse button, drag the cursor to define the test area, and release the mouse button.

   The Properties box displays the properties of the selected area:

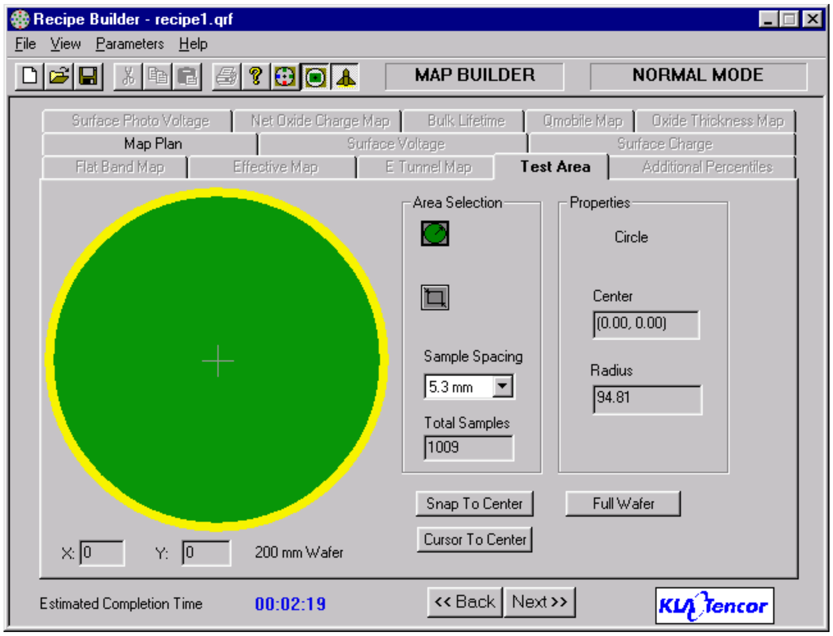
   – For a rectangle, the Properties box displays the coordinates of the upper left and lower right corner of the rectangle and the area of the rectangle.
   – For a circle, the Properties box displays the coordinates of the center of the circle and the radius of the circle.

6. If you wish to center the test area on the center of the wafer graphic, click the Snap To Center button.

7. In the Sample Spacing drop-down menu, select a spacing between 4 and 50 mm.

   The number of Total Samples depends on the size of the test area and the sample spacing selected.

8. When finished defining the test area, click the Next button and define the Additional Percentile values to be used for reporting the Map data.



Center: (0.00, 0.00)

Radius: 94.81

Sample Spacing: 5.3 mm

Total Samples: 1009

X: 0 Y: 0 200 mm Wafer

Estimated Completion Time 00:02:19

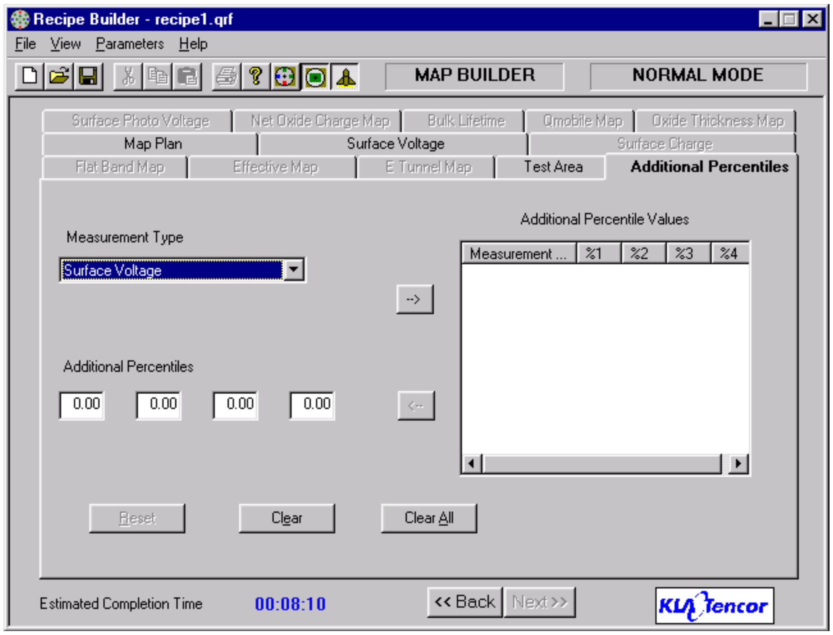
**Figure 3-13**: Test Area

# Additional Percentiles

The Additional Percentiles page (Figure 3-14) allows you to define additional percentile values at which to report data. (Previously, lot statistics for maps displayed in the Report Generator and Data Wizard were limited to 10%, 50%, and 90%.)

To define an additional set of percentile values for a measurement type:

1. Select the Measurement Type from the drop-down list.
2. Enter the desired percentile values in the Additional Percentiles fields.
   – Press the tab key to move from one field to the next.
   – Enter values from 0 to 100 (except 10, 50, and 90). Decimal values are limited to two places to the right of the decimal point.
3. When satisfied with the values, click the right-arrow button to add the entries to the list of Additional Percentile Values.
4. Repeat steps 1 through 3 for each Measurement Type.
   – To edit an entry in the list, click it, then click the left-arrow button and edit the values as described in steps 2 and 3.
   – To delete an entry from the list, click it, then click Clear.
   – To delete all entries, click Clear All.
5. When finished defining the additional percentiles, you can click the Back button to review the Map tests.
6. When finished building the recipe, proceed to “Saving the Recipe” on page 3-27.



Measurement Type: Surface Voltage

Additional Percentiles: 0.00 0.00 0.00 0.00

Estimated Completion Time 00:08:10

**Figure 3-14**: Additional Percentiles

# Saving the Recipe

When you’ve finished building the recipe, save it as follows:

1. From the File menu, select Save.

   The Save Recipe window opens (Figure 3-15) with the first Library, Book, and Recipe in each column selected. Recipe files (*.qrf) are stored in Book subdirectories within Library directories. Libraries reside in C:\Quantox\Recipes.

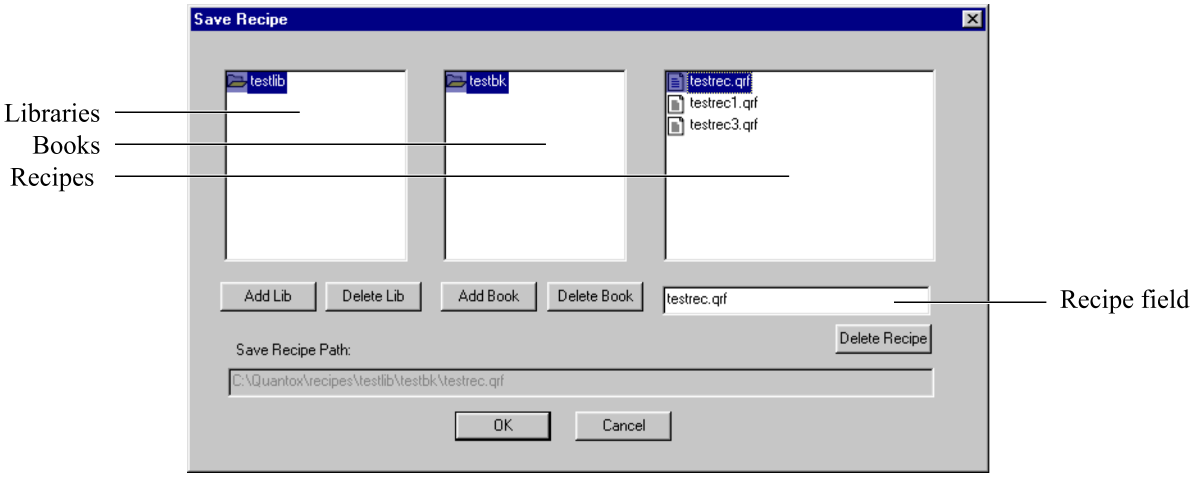
2. Click to select the Library and Book that you wish to store the Recipe in.

   - To create a new Library, click the Add Lib button, type a name for the new Library, and click OK.
   - To create a new Book, select the Library you wish to store the Book in, click the Add Book button, type a name for the new Book, and click OK.

3. With the Library and Book selected, type a name for the new Recipe in the Recipe field (the software automatically appends the .qrf extension).

4. Click OK to Save the Recipe.

   The Save Recipe window closes.



testrec.qrf

Save Recipe Path: C:\Quantox\recipes\testlib\testbk\testrec.qrf

**Figure 3-15**: Save Recipe Dialog Box

# Deleting a Library, Book, or Recipe

**CAUTION**

If you delete a Library, you also delete all Books and Recipes in the Library. If you delete a Book, you also delete all Recipes in the Book.

1. If the Save Recipe window is not open, select Save As to open the window.
2. Select the Library, Book, or Recipe you want to delete.
3. Click the appropriate Delete button.

   A dialog box opens, identifying the item (Library, Book, or Recipe) that is deleted.
4. Click OK to confirm that the correct item is selected, or Cancel to return to the Save Recipe window.

   A dialog box opens to alert you that the item will be deleted.
5. Click Yes or Yes to All to confirm the deletion, or click Cancel to cancel the deletion.

# Site Tests and Map Tests

The Recipe Builder offers two types of tests, Site tests and Map tests. Depending on production requirements, a single recipe can include Site tests, Map tests or a combination of both. When a single recipe includes both Site and Map tests, Map tests are performed before Site test to prevent charge biasing.

## Site Tests

Site tests are tests that measure individual sites on the wafer. Many site tests use data from a Q-V-SPV curve. Each point on the Q-V-SPV curve is determined by depositing a known amount of charge (Q) on the surface of the wafer, measuring the true surface potential (V) of the oxide, and measuring the surface photovoltage (SPV). This procedure is repeated several times for varying amounts of charge, and the values are used to plot the Q-V-SPV curve. Curve data, used with various formulas, provide the flatband voltage, effective charge, interface trap density, oxide thickness, intrinsic oxide leakage, threshold voltage, midband voltage, mobile charge, and doping measurement. Other site tests use data captured from the actual transient SPV curve. These measurements use corona biasing, and return measurements from the analysis of the acquired SPV curve. These measurements include recombination lifetime, bulk recombination lifetime, and iron concentration.

Site tests (excluding surface doping and mobile charge) require only a few minutes per site to collect data for the Q-V curve. The data undergoes different calculations for the different tests, but the data is collected only once per site. Thus, the total time to calculate several test results from the Q-V curve is only slightly longer than the time to obtain the Q-V curve. The surface doping test takes longer because a field-induced junction must be formed. The mobile charge test adds additional time because the wafer must be heated and cooled between tests.

Quantox Site tests and testing parameters are described on Pages 32 through 79.

## Map Tests

Map tests are tests that measure a defined area of the wafer. In principle, map-based measurements are closely related to site-based measurements with the exception that map-based measurements employ blanket corona charging. An enhanced corona source (*blanket wire* source) provides a uniform corona bias on the entire wafer surface.

Because these tests map the entire wafer, the system must be able to ignore data collected at *non-existent* wafer sites (such as the flat or notch). The test engineer enables this by describing the layout of the wafer in the Wafer Description window (Parameters Menu). The system can then calculate the measurements for the valid area and ignore data collected at non-existent site.

Quantox Map tests and testing parameters are described on pages 84 through 100.

**Site tests include**

- Oxide Thickness ($T_{ox}$)
- Gate $T_{ox}$
- Effective Charge ($Q_{eff}$)
- Mobile Charge ($Q_m$)
- V0/SPV0
- Oxide Resistivity
- Flatband Voltage ($V_{fb}$)
- Surface Doping
- Iron Concentration
- MidBand Voltage ($V_{mid}$)
- Interface Trap ($D_{it}$)
- Threshold Voltage ($V_t$)
- Bulk Recombination Lifetime
- Total Charge ($Q_{tot}$)
- Generation Lifetime
- Recombination Lifetime
- Tunneling Charge ($E_{tunnel}$)

**Map tests include**

- Surface Voltage Map ($V_s$)
- Surface Charge Map ($Q_{surf}$)
- Surface PhotoVoltage Map (SPV)
- Net Oxide Charge Map ($Q_{net}$)
- Oxide Thickness Map ($T_{ox}$)
- Flatband Voltage Map ($V_{fb}$)
- Effective Charge Map ($Q_{eff}$)
- Qmobile Map ($Q_m$)
- Bulk Lifetime Map
- Tunneling Charge Map ($E_{tunnel}$)

## Testing Sequence

The following list shows the default order in which tests are performed for each wafer. (You can change the order using the **Measurement Order** field under the **Gate $T_{ox}$** tab.)

BackSide Contact <if desired>

 PreHeat for Initial-Wafer_State (V_0/SPV-0)

Initial-Wafer_State [V_0/SPV-0 (if needed)]

 PreHeat for $V_{surf}$ Map

Non-Corona Maps ($V_s$ | $S_{pv}$ | $Q_{net}$)

 Site - Gate$T_{ox}$-Site (Report Gate$T_{ox}$ IF Doping = Assumed & $V_{fb}$ = Assumed) (Save Q for $Q_{total}$)

 PreHeat for $V_{fb}$ Site

Site - QV Test ($T_{ox}$, $Q_{tot}$, $V_{fb}$, $V_{mid}$, Leakage, $V_t$, $D_{it}$-Default Doping

 PreHeat for Corona Maps ($T_{ox}$ | $V_{fb}$ | $D_{it}$ | Leakage)

Corona Maps ($T_{ox}$ | $V_{fb}$ | $D_{it}$-TBD | Leakage-TBD)

BTauR Map

Site - Junction Test (Doping, $G_{Life}$, $SR_{Life}$, $BR_{Life}$)

Calc $D_{it}$ for (Measured-Doping | Best-Measured-Doping)

Calc Gate$T_{ox}$ for ($V_{fb}$-method & | Doping-method)

Iron-Site

 PreHeat for $Q_{mobile}$-Map

$Q_{mobile}$-Map

 PreHeat for $Q_{mobile}$-Site

$Q_{mobile}$-Site

$E_{tunnel}$-Map

$E_{tunnel}$-Site

# Oxide Thickness ($T_{ox}$)

$T_{ox}$ is obtained by plotting Q versus V. The slope of the curve at the extreme regions approximately corresponds to the oxide capacitance. The calculation for oxide thickness is approximately:

$$Q = CV \qquad C = \frac{\varepsilon_{OX} A}{T_{OX}}$$

$$Q = \frac{\varepsilon_{OX} A}{T_{OX}} V$$

$$T_{ox} = \frac{V \varepsilon_{OX} A}{Q}$$

where:

$\varepsilon_{OX}$ = The dielectric constant of the oxide.

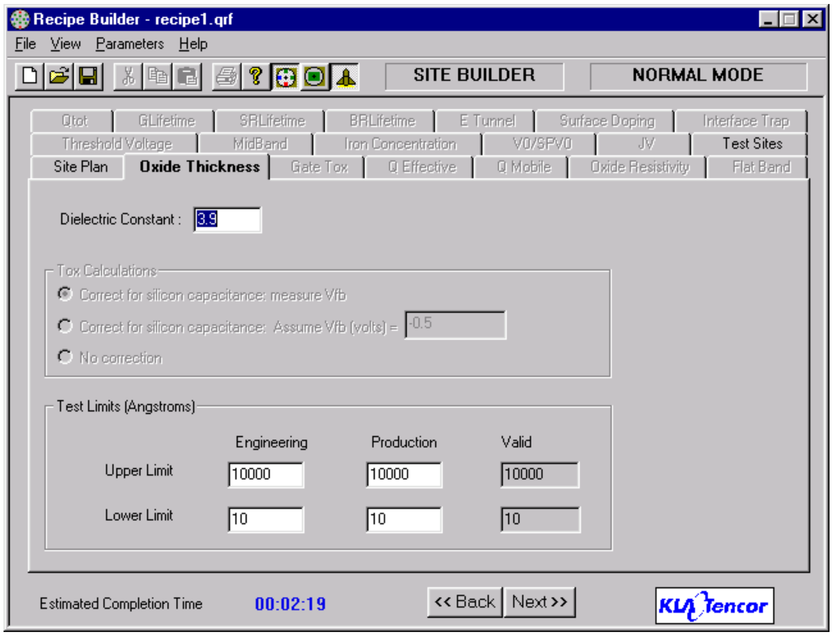
$T_{OX}$ = The oxide thickness.

**NOTE**

In practice, a more sophisticated model is used to calculate the oxide thickness. This model takes into account the effect of having silicon underneath the oxide.

## Test Parameters

Figure 3-16 shows the Oxide Thickness tab. Table 3-6 describes the parameters.



Dielectric Constant : 3.9

Tox Calculations

● Correct for silicon capacitance: measure Vfb

○ Correct for silicon capacitance: Assume Vfb (volts) = -0.5

○ No correction

Test Limits (Angstroms)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 10000 | 10000 | 10000 |
| Lower Limit | 10 | 10 | 10 |

Estimated Completion Time 00:02:19

**Figure 3-16**: Oxide Thickness Setup, Site Test

**Table 3-6**: Oxide Thickness Parameters

| Parameter | Options | Description |
|---|---|---|
| Dielectric Constant | user-defined value | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Test Limits | user-defined (Å) | See Table 3-5. |

# GateT$_{ox}$

The Gate $T_{ox}$ measurement can be performed instead of, or in addition to, a normal oxide thickness measurement. Gate $T_{ox}$ is particularly suited for SPC monitoring of ultra-thin oxides that are well characterized. Unlike normal oxide thickness measurement, a Gate $T_{ox}$ measurement does not take a complete curve of data extending from strong inversion to strong accumulation. This reduction in data collection significantly improves the speed of the measurement.

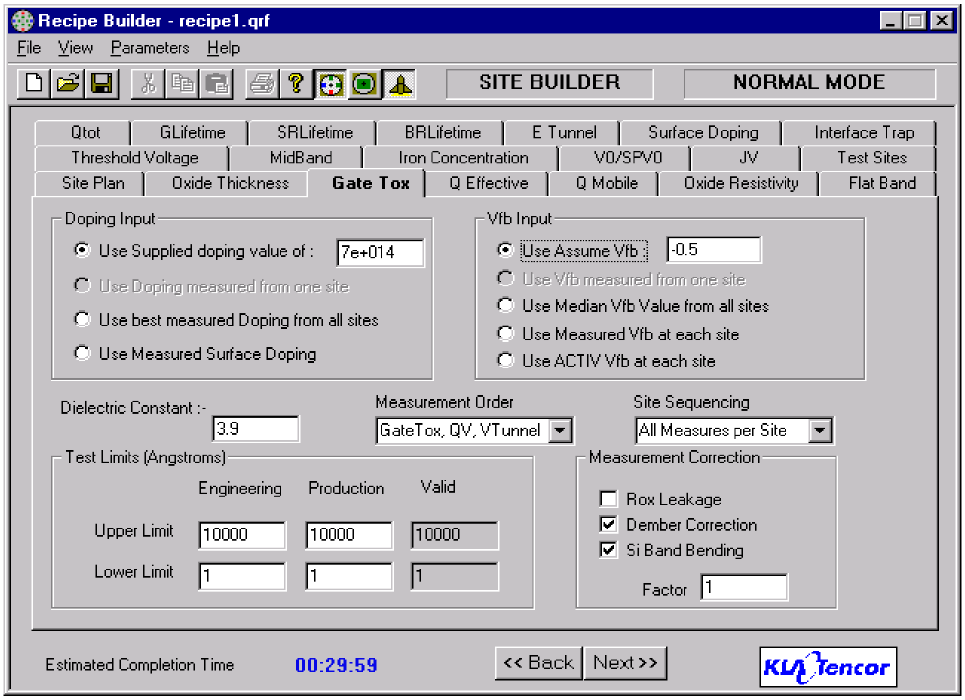
Because a full sweep of data is not obtained, the calculations for oxide thickness require that the user provide estimates of Doping and $V_{fb}$. These parameters have a second-order effect on oxide thickness, and in many cases, the default values are sufficient. If you prefer, you can direct the system to measure Doping and $V_{fb}$ either site-by-site or by using single representative value for the wafer.

**NOTE**

Gate $T_{ox}$ measurements require setting up an abbreviated two-point manual sweep (see “Setting Recipe Parameters” on page 3-4). Measurements made using the Gate $T_{ox}$ sweep are not as flexible as measurements that employ the conventional sweep.

## Test Parameters

Figure 3-17 shows the Gate T$_{ox}$ tab. Table 3-7 describes the test parameters.



Doping Input

- ● Use Supplied doping value of : 7e+014
- ○ Use Doping measured from one site
- ○ Use best measured Doping from all sites
- ○ Use Measured Surface Doping

Vfb Input

- ● Use Assume Vfb : -0.5
- ○ Use Vfb measured from one site
- ○ Use Median Vfb Value from all sites
- ○ Use Measured Vfb at each site
- ○ Use ACTIV Vfb at each site

Dielectric Constant :- 3.9

Measurement Order: GateTox, QV, VTunnel

Site Sequencing: All Measures per Site

Test Limits (Angstroms)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 10000 | 10000 | 10000 |
| Lower Limit | 1 | 1 | 1 |

Measurement Correction

- ☐ Rox Leakage
- ☑ Dember Correction
- ☑ Si Band Bending

Factor 1

Estimated Completion Time 00:29:59

**Figure 3-17**: Gate T$_{ox}$, Site Test

**Table 3-7**: Gate T$_{ox}$ Parameters

| Parameter | Options | Description |
|---|---|---|
| Doping Input | Use Supplied Doping value of | The software uses the value entered in this field to calculate oxide thickness for all selected sites. This option might be sufficient when the substrate resistivity is well-controlled. If the substrate resistivity varies by more than two times, one of the "measure doping" options might be required.<br>This field is linked to the corresponding field in the Wafer Description dialog. A change to the value in one of these fields is reflected in the other. |

**Table 3-7**: Gate $T_{ox}$ Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| | Use Doping measured from one site | Use only if you ***have not*** selected Surface Doping in the Site Plan.<br>Beginning with Site 1, the system makes measurements until it finds a ***non-bad*** value. The software then uses this value to calculate oxide thickness at all selected sites. If all values are bad, the software uses the ***assumed*** value from the Wafer Description dialog. |
| | Use best measured Doping from all sites | Use only if Surface Doping ***is*** selected in the Site Plan.<br>The software determines the best doping value from the ***n*** sites tested and use the value to calculate oxide thickness for ***all*** selected sites. (The best doping value is generally the lowest value obtained. Poor silicon quality tends to increase the reported doping value.) |
| | Use Measured Surface Doping | Use only if Surface Doping ***is*** selected in the Site Plan.<br>The software uses the measured doping value for each site to calculate the oxide thickness for the site. |
| $V_{fb}$ Input | Use Assume $V_{fb}$ | The software uses the value entered in this field to calculate oxide thickness for all selected sites.<br>This field is linked to the corresponding field in the Wafer Description dialog. A change to the value in one of these fields is reflected in the other. |

**Table 3-7**: Gate T$_{ox}$ Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| | Use V$_{fb}$ measured from one site | Use only if you ***have not*** selected Voltage in the Site Plan.<br>Beginning with Site 1, the system makes measurements until it finds a ***non-bad*** value. The software then uses this value to calculate oxide thickness at all selected sites. If all values are bad, the software uses the ***assumed*** value from the Wafer Description dialog. |
| | Use Median V$_{fb}$ Value from all sites | Use only if Flat Band Voltage ***is*** selected in the Site Plan.<br>The software uses the median V$_{fb}$ value to calculate ***all*** site-based Gate T$_{ox}$ measurements. |
| | Use Measured V$_{fb}$ at each site | Use only if Flat Band Voltage ***is*** selected in the Site Plan.<br>The software uses the measured V$_{fb}$ value for each site to calculate the oxide thickness for the site. |
| | Use ACTIV Vfb at each site | Directs the software to estimate V$_{fb}$ from the Vs value at the SPV pre-bias condition. |
| Dielectric Constant | user-defined value | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Measurement Order | QV, V$_{Tunnel}$, Gate T$_{ox}$<br>V$_{Tunnel}$, QV, Gate T$_{ox}$<br>QV, Gate T$_{ox}$, V$_{Tunnel}$ | Enables you to define the sequence order between V$_{fb}$, V$_{Tunnel}$/E$_{Tunnel}$, and Gate T$_{ox}$. |
| Site Sequencing | All Measures per Site<br>All Sites per Measure | Enables you to define whether all measurements are performed on one site (that is, QV and V$_{Tunnel}$ executed on Site 1, then QV and V$_{Tunnel}$ executed on Site 2), or whether the first measurement is executed on all sites before the next measurement type (that is, QV on Site 1 and 2, then V$_{Tunnel}$ on Site 1 and 2). |

**Table 3-7**: Gate $T_{ox}$ Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Measurement Correction | $R_{ox}$ Leakage<br>Dember Correction<br>Si Band Bending | Enables you to correct for the Dember potential and Si bandbending.<br>$R_{ox}$ Leakage correction is only available if $R_{ox}$ measurement is included in the recipe.<br>Default Si bandbending factor: 1 (range: 0.00 to 5.00) |
| Test Limits | user defined (Angstroms) | See Table 3-5. |

# Effective Charge ($Q_{eff}$)

$Q_{eff}$ is derived from the measured flatband voltage. The flatband voltage is determined by the amount of charge located near the surface of the wafer. If the charge is on the surface of the oxide, it does not affect the flatband voltage. Only charges near the silicon interface produce a flatband voltage. $Q_{eff}$ is independent of the oxide thickness.

The following equation is used to calculate $Q_{eff}$.

$$Q_{eff} = C_{OX} V_{FB} \qquad C = \frac{\varepsilon_{OX} A}{T_{OX}}$$

$$Q_{eff} = \frac{\varepsilon_{OX} A}{T_{OX}} V_{FB}$$

$$\frac{Q}{A} = \frac{\varepsilon_{OX}}{T_{OX}} V_{FB}$$

where:

$\varepsilon_{ox}$ = The dielectric constant of the oxide.

$V_{fb}$ = The flatband voltage.

$T_{ox}$ = The oxide thickness.

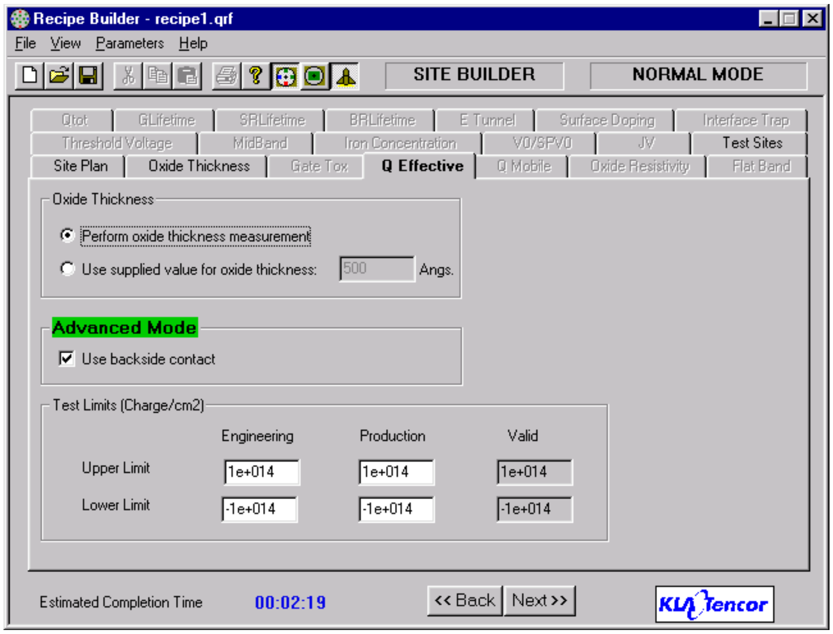
$Q_{eff}$ = The effective charge.

$A$ = The area of the test site.

$C_{ox}$ = The capacitance of the oxide.

## Test Parameters

Figure 3-18 shows the $Q_{eff}$ tab. Table 3-8 describes the testing parameters.



Oxide Thickness

● Perform oxide thickness measurement

○ Use supplied value for oxide thickness: 500 Angs.

Advanced Mode

☑ Use backside contact

Test Limits (Charge/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+014 | 1e+014 | 1e+014 |
| Lower Limit | -1e+014 | -1e+014 | -1e+014 |

Estimated Completion Time 00:02:19

**Figure 3-18**: Effective Charge Setup, Site Test

**Table 3-8**: Effective Charge Parameters

| Parameter | Options | Description |
|---|---|---|
| Oxide Thickness | Perform oxide thickness measurement | The system measures the oxide and uses the value in calculating $Q_{eff}$. |
| | User-supplied value for oxide thickness. | The system uses the value entered in the oxide thickness field. An incorrect value produces inaccurate results.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all.<br>Because oxide thickness and $Q_{eff}$ can be calculated from the same Q-V-SPV data, supplying the oxide thickness does not improve measurement speed. |

**Table 3-8**: Effective Charge Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Use backside contact<br>(Advanced Mode) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (Charge/cm$^2$) | See Table 3-5. |

# Mobile Charge ($Q_m$)

To measure $Q_m$, the Quantox system uses the bias temperature stress (BTS) technique. Rather than measure changes in flatband voltage before and after BTS, the system measures changes in surface voltage before and after BTS. This method eliminates errors introduced by changes in flatband voltage due to changes in $D_{it}$ occupancy.

To measure $Q_m$, a positive corona charge is deposited on the oxide surface and is then followed by a heating cycle (push cycle). This BTS cycle allows all of the positively charged mobile ions to be transferred to the oxide/silicon interface. Next, negative charge is deposited on the oxide surface, and the first surface voltage measurement is taken. The surface voltage measurement is influenced by all charges on the oxide with those near the oxide/air interface providing the largest contribution. Finally, a second temperature cycle is performed (pull cycle), and because a negative charge was placed on the oxide surface, the mobile charge shifts from oxide/silicon interface to the air/silicon interface. A second surface voltage measurement is taken at this point, and $Q_m$ is calculated.

$Q_m$ is calculated using the following calculation:

$$Q_m = C_{ox} * \Delta V_{ox}$$

where:

$C_{ox}$ = The oxide capacitance per unit area

$\Delta V_{ox}$ = {Oxide voltage before pull cycle - Oxide voltage after pull cycle}

---

**NOTE**

Several pull cycles can be performed to minimize oxide leakage. In addition, leakage correction is added to the $Q_m$ algorithm.

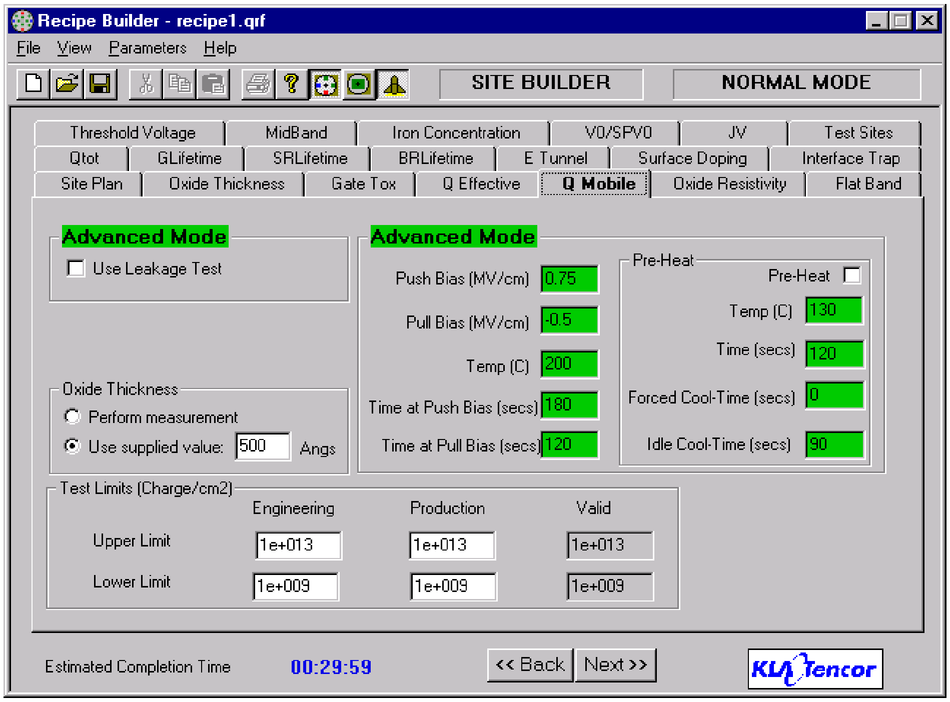
---

## Test Parameters

Figure 3-19 shows the Mobile Charge tab. Table 3-9 describes the parameters.

**NOTE**

Do not change the Advanced Mode defaults without consulting your KLA-Tencor Applications representative. Otherwise, accuracy and precision might suffer.



**Advanced Mode**

☐ Use Leakage Test

Oxide Thickness

○ Perform measurement

● Use supplied value: 500 Angs

**Advanced Mode**

Push Bias (MV/cm) 0.75

Pull Bias (MV/cm) -0.5

Temp (C) 200

Time at Push Bias (secs) 180

Time at Pull Bias (secs) 120

Pre-Heat

Pre-Heat ☐

Temp (C) 130

Time (secs) 120

Forced Cool-Time (secs) 0

Idle Cool-Time (secs) 90

Test Limits (Charge/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+013 | 1e+013 | 1e+013 |
| Lower Limit | 1e+009 | 1e+009 | 1e+009 |

Estimated Completion Time 00:29:59

**Figure 3-19**: Mobile Charge, Site Test

**Table 3-9**: Mobile Charge Parameters

| Parameter | Options | Description |
|---|---|---|
| Use Leakage Test (Advanced Mode) | checked or not checked | Tests for leaky oxide |
| Push and Pull Bias (Advanced Mode) | user-defined values | Specifies individual Push and Pull bias (MV/cm), heating temperature (°C), and the time at bias (seconds) |

**Table 3-9**: Mobile Charge Parameters (Continued)

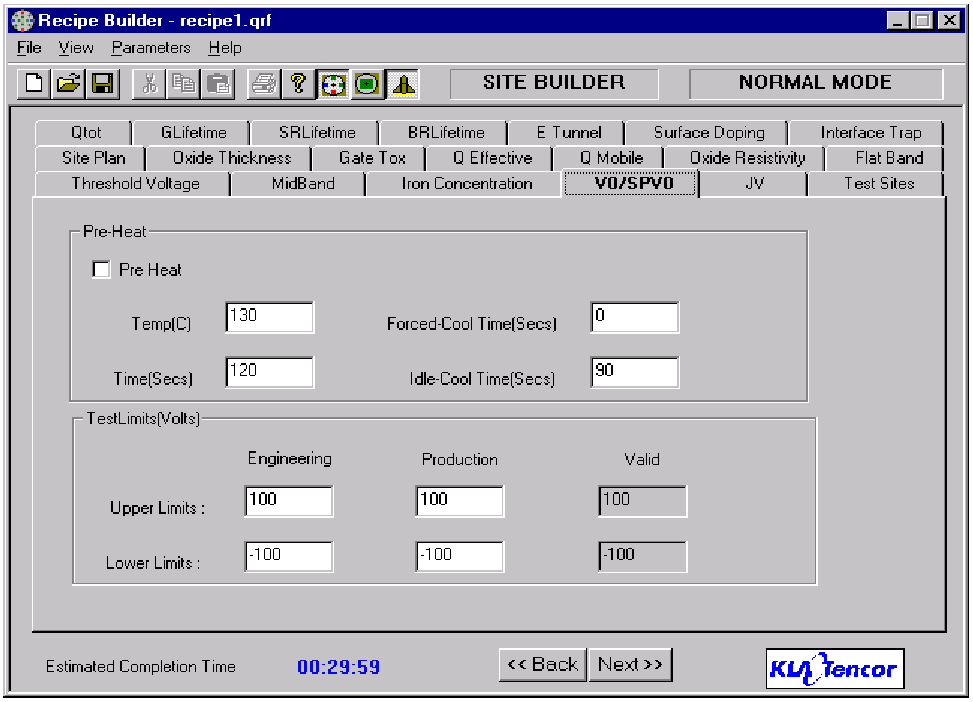
| Parameter | Options | Description |
|---|---|---|
| PreHeat (Advanced Mode) | Temp (C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only) Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled either by forcing $N_2$ into the cooling chamber or by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Oxide Thickness | Perform measurement | The system measures the oxide and uses the value in calculating $Q_{m.}$ |
| | Use supplied value | The system uses the value entered in the oxide thickness field. An incorrect value produces inaccurate results.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all.<br>Because oxide thickness and $Q_m$ can be calculated from the same Q-V-SPV data, supplying the oxide thickness does not improve measurement speed, if other parameters such as $T_{ox}$ and $V_{fb}$ are also part of the recipe. |
| Test Limits | user-defined (charge/cm$^2$) | See Table 3-5. |

# V0/SPV0

V0/SPV0 (Figure 3-20) is a site-based measurement of the initial wafer state.

## Test Parameters

Figure 3-20 shows the V0/SPV0 tab. Table 3-10 describes the parameters.



Pre-Heat

☐ Pre Heat

| | | | |
|---|---|---|---|
| Temp(C) | 130 | Forced-Cool Time(Secs) | 0 |
| Time(Secs) | 120 | Idle-Cool Time(Secs) | 90 |

TestLimits(Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limits : | 100 | 100 | 100 |
| Lower Limits : | -100 | -100 | -100 |

Estimated Completion Time 00:29:59

**Figure 3-20**: V0/SPV0, Site Measurement

**Table 3-10**: V0/SPV0 Parameters

| Parameter | Options | Description |
|---|---|---|
| Pre Heat | Temp (C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only) Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled either by forcing $N_2$ into the cooling chamber or by allowing the wafer to sit idle in the chamber for the indicated idle time. |

**Table 3-10**: V0/SPV0 Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Test Limits | user-defined (volts) | See Table 3-5. |

# Oxide Resistivity

Oxide resistivity is a measurement of the resistivity of the oxide at the site under test. The Quantox system performs this measurement by biasing the oxide to a given electric field. The voltage is then measured. If the oxide is conducting current, the voltage decreases with time. If the leakage is assumed to be ohmic, an estimate of the resistivity can be obtained by assuming a simple time evolution of the voltage given by the equation:

$$V(t) = V_0^{exp}(-t/R_{ox}C_{ox})$$

where:

$V_0$ = The initial surface voltage

$V(t)$ = The surface voltage as it evolves in time

$R_{ox}$ = The oxide resistance

$C_{ox}$ = The oxide capacitance

The oxide resistance can be expressed as a thickness independent parameter, the resistivity (units of ohm-cm). This is the parameter reported by the Quantox. Higher values indicate a higher quality oxide.

$$\rho_{OX} = (R_{OX})\left(\frac{A}{T_{OX}}\right)$$

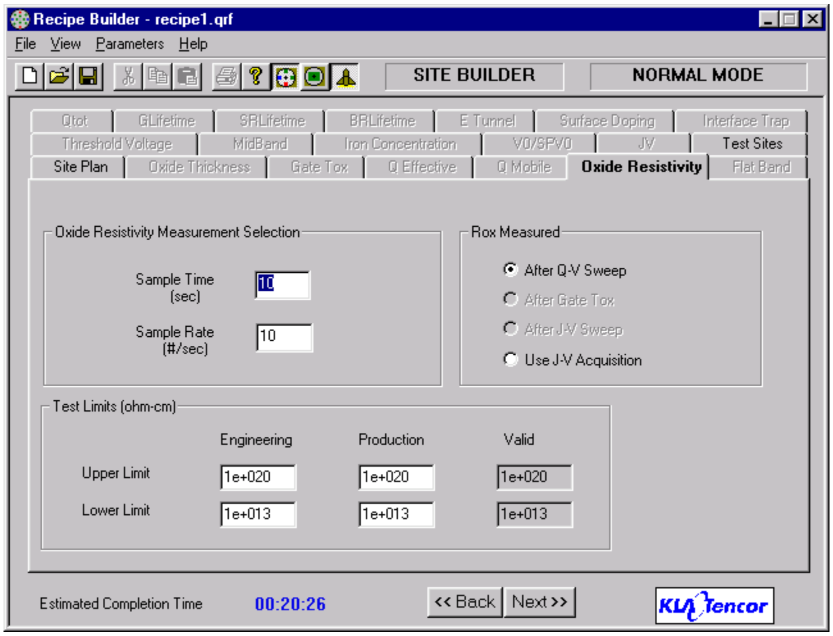
$\rho_{ox}$ = The oxide resistivity

$A$ = The capacitive area

$T_{ox}$ = The oxide thickness

## Test Parameters

Figure 3-21 shows the Oxide Resistivity tab. Table 3-11 describes the test parameters.



Oxide Resistivity Measurement Selection

Sample Time (sec): 10

Sample Rate (#/sec): 10

Rox Measured

- ● After Q-V Sweep
- ○ After Gate Tox
- ○ After J-V Sweep
- ○ Use J-V Acquisition

Test Limits (ohm-cm)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+020 | 1e+020 | 1e+020 |
| Lower Limit | 1e+013 | 1e+013 | 1e+013 |

Estimated Completion Time 00:20:26

**Figure 3-21**: Oxide Resistivity Setup, Site Test

**Table 3-11**: Oxide Resistivity Parameters

| Parameter | Options | Description |
|---|---|---|
| Sample Time<br>Sample Rate | Sample Time Range: 1 to 600<br>Sample Rate Range: 0.1 to 10<br>Valid data points are from 10 to 1024. | Enables you to enter values for Sample Time (seconds) and Sample Rate (samples per second). The default value for each is 10. |

**Table 3-11**: Oxide Resistivity Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| $R_{ox}$ Measured | After Q-V Sweep<br>After Gate $T_{ox}$ | This selection determines when the $R_{ox}$ measurement is made. The default selection varies depending on the site measurements currently selected.<br>If any measurement that requires a Q-V Sweep has been selected in the Site Plan, After Q-V is the default option.<br>After Gate $T_{ox}$ is only available if the Gate $T_{ox}$ measurement is selected in the Site plan.<br>If a measurement requiring a Q-V Sweep is not selected, and the Gate $T_{ox}$ measurement is selected, After Gate $T_{ox}$ is the default.<br>The default selection varies depending upon the site measurements currently selected.<br>If either option is selected, the amount of charge used for the $R_{ox}$ measurement is the amount in the last step of the last segment in the corresponding sweep parameters chosen with this radio button. |

# Flatband Voltage ($V_{fb}$)

$V_{fb}$ is a measure of how much charge is in the oxide, particularly near the oxide/silicon interface. Figure 3-22 shows the location of flatband voltage on a V-SPV plot.

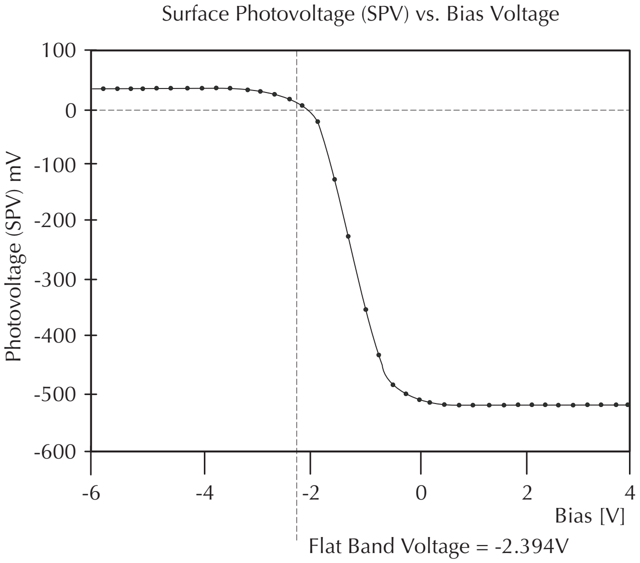


**Figure 3-22**: Flatband Voltage Plot

If the SPV voltage is plotted as a function of the surface potential (V), the voltage at which SPV = 0 volts is the flatband voltage. Quantox software makes a small correction for the Dember potential. The backside contact is used as a point of reference. If the backside contact is not used, the curve is sometimes shifted by a DC offset on the x-axis. The flatband voltage can be calculated using the following equation:

$$V_{fb} = -\frac{1}{\varepsilon_{ox}}\int_0^{T_{ox}} dx\,\rho(x)\cdot x + W_{ms}$$

where:

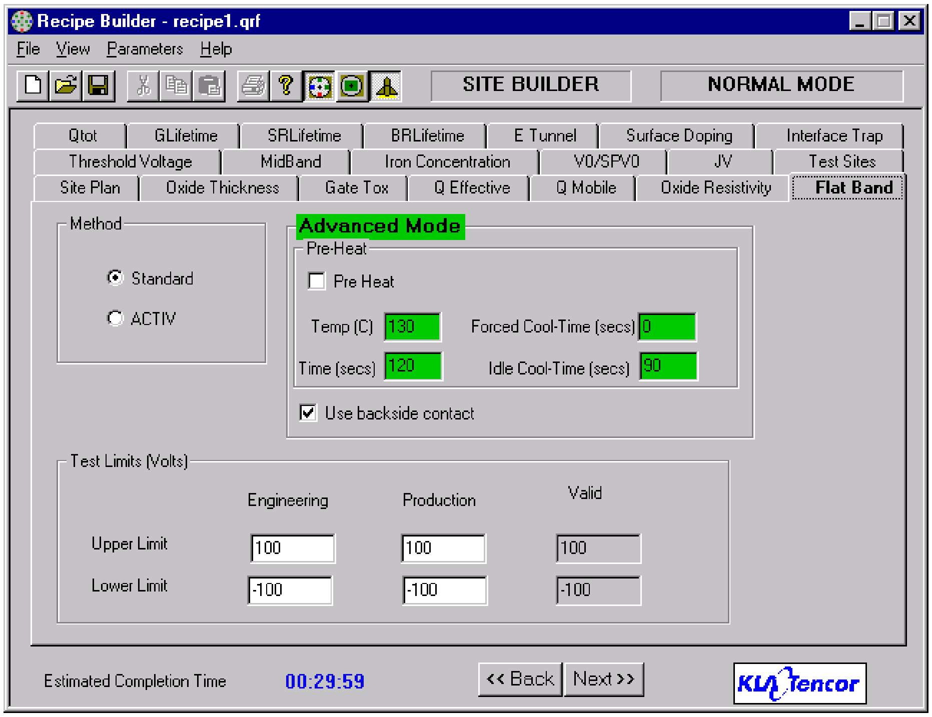
$\rho(x)$ = The density of charge distributed throughout the oxide.

$\varepsilon_{ox}$ = The dielectric constant of the oxide.

$W_{ms}$ = The DC offset due to the work function difference between the metal of the sensor and the silicon of the wafer.

## Test Parameters

Figure 3-23 shows the Flatband Voltage tab. Table 3-12 describes the test parameters.



Method
● Standard
○ ACTIV

Advanced Mode

Pre-Heat
☐ Pre Heat
Temp (C) 130
Forced Cool-Time (secs) 0
Time (secs) 120
Idle Cool-Time (secs) 90

☑ Use backside contact

Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 100 | 100 | 100 |
| Lower Limit | -100 | -100 | -100 |

Estimated Completion Time 00:29:59

**Figure 3-23**: Flatband Voltage Setup, Site Test

**Table 3-12**: Flatband Voltage Parameters

| Parameter | Options | Description |
|---|---|---|
| PreHeat<br>(Advanced Mode) | Temp (C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time. This option reduces the ~0.3 V offset in $V_{fb}$ due to airborne molecular contamination.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Method | Standard<br>ACTIV | ACTIV directs the software to estimate $V_{fb}$ from the $V_s$ value at the SPV pre-bias condition. |

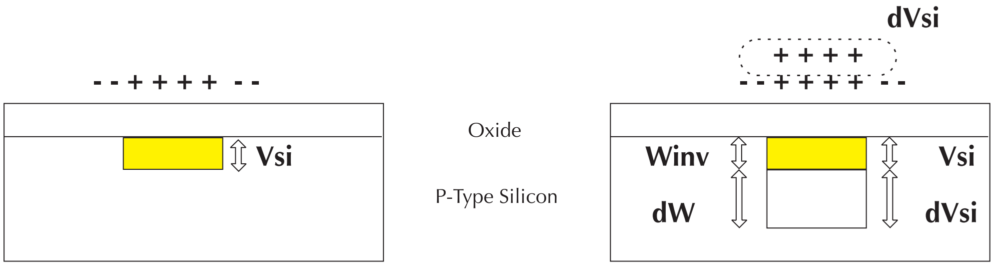
**Table 3-12**: Flatband Voltage Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Use backside contact<br>(Advanced Mode) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-entered (volts) | See Table 3-5. |

# Surface Doping

Surface doping is a measure of the average doping in the top few microns of the semiconductor. This measurement is done by forming a field-induced junction and pulsing it into deep depletion in a manner similar to pulsed C-V. Data is analyzed in a manner similar to conventional C-V measurements.

The junction is formed by creating an accumulation region at the test site using the appropriate corona polarity and a large corona source. A small corona source is then used to form an inverted region in the middle. The accumulation region acts as a guard ring that suppresses lateral conduction to give the junction a well-defined area. The diameter of the junction is measured with a special sensor for later calculations. The left side of Figure 3-24 shows a field induced P-N junction.



$$N(d) = f(dQ, dV_{si})$$

**Figure 3-24**: Surface Doping

Next, the junction is pulsed into deep depletion with an applied charge of $dQ$ as indicated on the right side of Figure 3-24. The resulting voltage transient is recorded. The deposited charge is immediately imaged in the silicon by repelling charges from acceptor/donor sites down to some depth $W_{dd}$. As minority carriers are generated, the junction eventually collapses and returns to its equilibrium depth, $W_{inv}$, and equilibrium voltage, $V_{si}$. During the measurement, the deposited charge $dQ$ and the temporary increase in voltage $dV_{si}$ are measured.

Doping is a function of the deposited charge variable $dQ$ and the voltage increase $dV_{si}$, wherein doping $N_d = f(dQ, dV_{si})$.

The calculation of doping proceeds as follows:

$$W_{dd} = W_{inv} + dW,$$

$$dQ = qN_d(dW)$$

The voltage during the depletion pulse is

$$dV_{si} + V_{si} = (qN_d/2\varepsilon_{si})(W_{dd})^2$$

Where the equilibrium silicon inversion voltage and depth are known to be related by:

$$V_{si} = (qN_d/2\varepsilon_{si})(W_{inv})^2$$

and expressions are known for the equilibrium silicon voltage,

$$V_{si} = (kT/q)ln[N_d/n_i + 2.08]$$

where:

$\varepsilon_{si}$ = The dielectric constant of the silicon.

$q$ = The charge on an electron.

$dQ$ = The charge per unit area applied in the deep depletion pulse.

$N_d$ = The majority carrier concentration near the surface.

$W_{dd}$ = The maximum depth pulsed to during the deep depletion pulse.

$W_{inv}$ = The equilibrium depletion depth.

$d\mathrm{W}$ = The change in depletion depth during the deep depletion pulse.

$V_{si}$ = The equilibrium voltage across the depletion region.

$dV_{si}$ = The voltage change across depletion region during deep depletion pulse.

$k$ = Boltzman's constant.

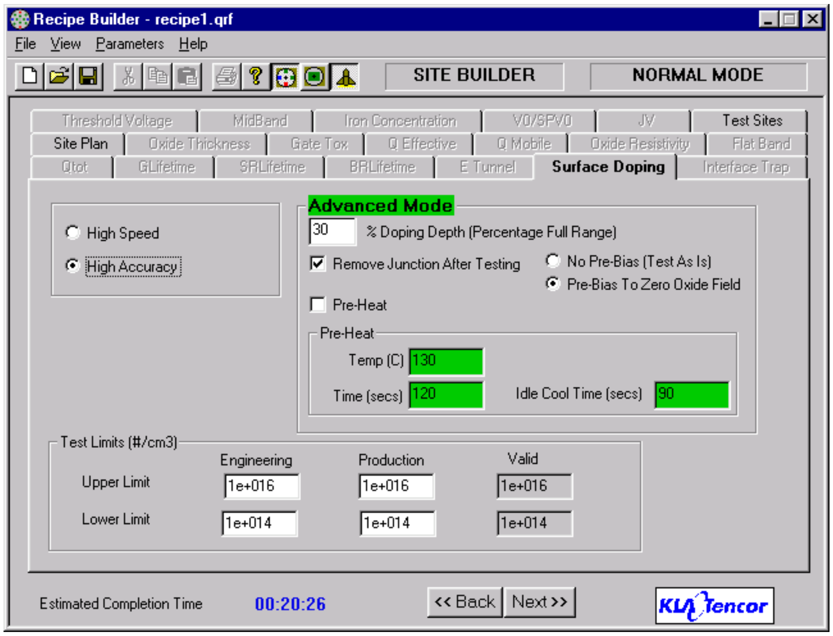
$T$ = The temperature.

$n_i$ = The intrinsic carrier concentration of the semiconductor.

Combining the equations leads to a transcendental expression for $\mathrm{N_d}$ which can be solved by an iterative method. The Report Generator prints out the average majority carrier doping (charge/cm$^3$) along with the maximum depth (cm) sampled.

## Test Parameters

Figure 3-25 shows the Surface Doping tab. Table 3-13 describes the parameters.



○ High Speed

● High Accuracy

**Advanced Mode**

30 % Doping Depth (Percentage Full Range)

☑ Remove Junction After Testing

○ No Pre-Bias (Test As Is)

● Pre-Bias To Zero Oxide Field

☐ Pre-Heat

Pre-Heat

Temp (C) 130

Time (secs) 120

Idle Cool Time (secs) 90

Test Limits (#/cm3)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+016 | 1e+016 | 1e+016 |
| Lower Limit | 1e+014 | 1e+014 | 1e+014 |

Estimated Completion Time 00:20:26

**Figure 3-25**: Surface Doping, Site Test

**Table 3-13**: Surface Doping Parameters

| Parameter | Options | Description |
|---|---|---|
| (test method) | High Speed | The diameter of the field-induced junction created for the measurement is assumed. |
| | High Accuracy | The diameter of the field-induced junction is measured. High Accuracy is the default setting. |
| % Doping Depth (Percentage Full Range)<br>(Advanced Mode) | | Controls the depth to which the doping measurement is made. Increasing the percentage causes the doping measurement to sample deeper into the silicon.<br>The same % Doping Depth value pulses to greater depths on wafers with lower doping. The Report Generator prints out the actual depth to which the doping is measured. |

**Table 3-13**: Surface Doping Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Remove Junction After Testing<br>(Advanced Mode) | checked or not checked. | This option must be used for repeated measurements at the same site and is checked by default.<br>This option is not necessary if repeated measurements are not made. Deselecting this option saves test time. |
| Pre-Bias<br>(Advanced Mode) | No Pre-Bias (Test As Is)<br>Pre-Bias To Zero Oxide Field | Pre-Bias prepares the site by biasing it to zero volts before forming the junction.<br>This option is not necessary for wafers with low incoming surface charge. Selecting No Pre-Bias saves test time. |
| PreHeat<br>(Advanced Mode) | Temp (°C) between 50 and 275<br>Time (secs) between 60 and 900<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 90 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Test Limits | user-defined (charge/cm$^3$) | See Table 3-5. |

# Iron Concentration

Site-based Iron Concentration is a quantitative measurement of the amount of iron present in the silicon at the site under test. An iron measurement is similar to a lifetime measurement in that it addresses issues related to the silicon purity and is not a measurement of oxide characteristics. Any impurities present in the silicon can degrade the performance of devices built on the contaminated silicon. Metals are a particularly problematic source of *lifetime killers* and are of considerable concern in process monitoring situations.

In boron-doped P-type silicon, a convenient mechanism exists to enable accurate measurement of iron contamination. Any iron present in the sample tends to associate with boron sites and form FeB *pairs* that are electrically less active to the lifetime measurement used by the Quantox system for this application. In an equilibrium condition, almost all of the iron pairs with boron. Under strong illumination with appropriate wavelengths the iron can be temporarily disassociated from the boron sites. This disassociated interstitial iron is much more electrically active. By measuring the lifetime before and after this disassociation process, the Quantox can accurately determine the level of Fe contamination present in the silicon sample. This relationship is described by the following formula:

$$Fe = C\left[\frac{1}{\tau_{initial}} - \frac{1}{\tau_{after\_disassociation}}\right]$$

where:

$C$ = an overall constant

$\tau_{initial}$ = medium injection bulk lifetime as measured before the light disassociation treatment.

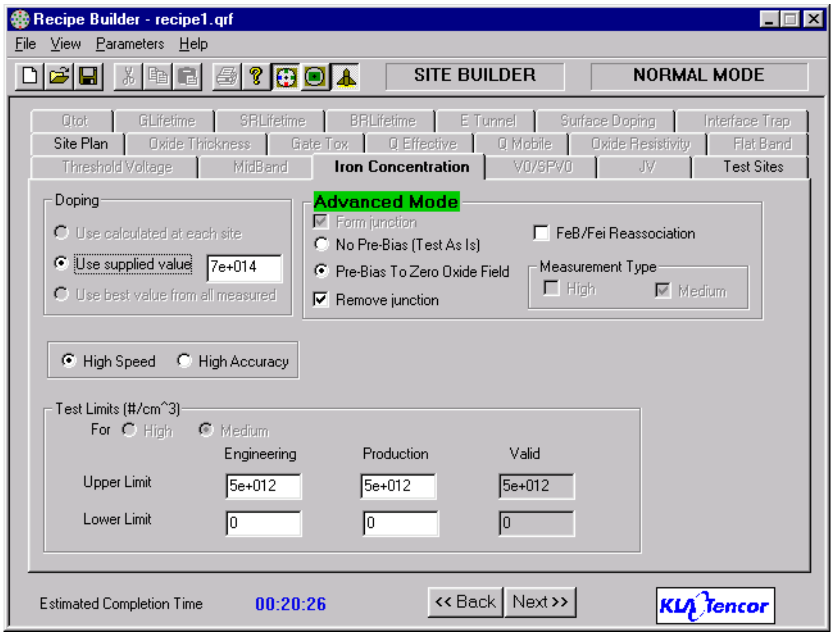
$\tau_{after\_disassociation}$ = medium injection bulk lifetime as measured after the light disassociation treatment.

The measurement makes use of the field-induced junctions in a manner similar to the site based bulk lifetime measurement. The iron measurement is performed as a separate pass after other lifetime measurements have been performed and does not make use of any data acquisition or junctions formed by other testing.

The report generator lists three values for each site under test. The first value is the iron concentration in units of #/cm$^3$. The second and third columns estimate the range (lower and upper limit) over which the measurement is expected to be accurate based on the starting lifetime.

## Test Parameters

Figure 3-26 shows the Iron Concentration tab. Table 3-14 describes the test parameters.



Doping
○ Use calculated at each site
● Use supplied value 7e+014
○ Use best value from all measured

Advanced Mode
☑ Form junction
○ No Pre-Bias (Test As Is)
● Pre-Bias To Zero Oxide Field
☑ Remove junction
☐ FeB/Fei Reassociation
Measurement Type
☐ High ☑ Medium

● High Speed ○ High Accuracy

Test Limits (#/cm^3)
For ○ High ● Medium

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 5e+012 | 5e+012 | 5e+012 |
| Lower Limit | 0 | 0 | 0 |

Estimated Completion Time 00:20:26

**Figure 3-26**: Iron Concentration, Site Test

**Table 3-14**: Iron Concentration Parameters

| Parameter | Options | Description |
|---|---|---|
| Doping | none | This setting is not currently used (leave as is). |
| Form Junction | none | This test requires a field-induced junction. |
| Pre-Bias<br>(Advanced Mode) | No Pre-Bias (Test As Is)<br>Pre-Bias To Zero Oxide Field | Pre-Bias prepares the site by biasing it to zero volts before forming the junction.<br>This option is not necessary for wafers with low incoming surface charge. Selecting No Pre-Bias saves test time. |
| Remove junction<br>(Advanced Mode) | checked or not checked | This option must be used for repeated measurements at the same site and is checked by default. |

**Table 3-14**: Iron Concentration Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| FeB/Fei Reassociation<br>(Advanced Mode) | checked or not checked | If a repeatability test is being performed, the iron present in the sample must be re-associated prior to subsequent repetitions. This can be achieved by letting the wafer sit at room temperature for a few days or alternatively, the re-association can be accelerated in an automated fashion by checking this box. The option directs the system to heat the wafer for approximately 40 minutes before each repetition.<br>This option is deselected by default and is generally not needed unless a repeatability test is being performed. |
|  | High Speed<br>High Accuracy | High Accuracy performs some additional signal averaging in the measurement acquisition.<br>High Speed provides a small improvement in speed however, the time saving is so small that this option is seldom recommended.<br>High Accuracy is the default setting. |
| Test Limits | user-defined (#/$cm^3$) | See Table 3-5. |

# Midband Voltage ($V_{mid}$)

$V_{mid}$ is used as a reference point in mobile charge measurements. On an SPV-V curve, the midband voltage is the point on the curve midway between the minimum and maximum SPV voltage (Figure 3-27). This point is where the slope of the curve is the steepest and most accurate. It is also at this point where the slope of the curve is less sensitive to noise and the effects of variations in $D_{it}$.

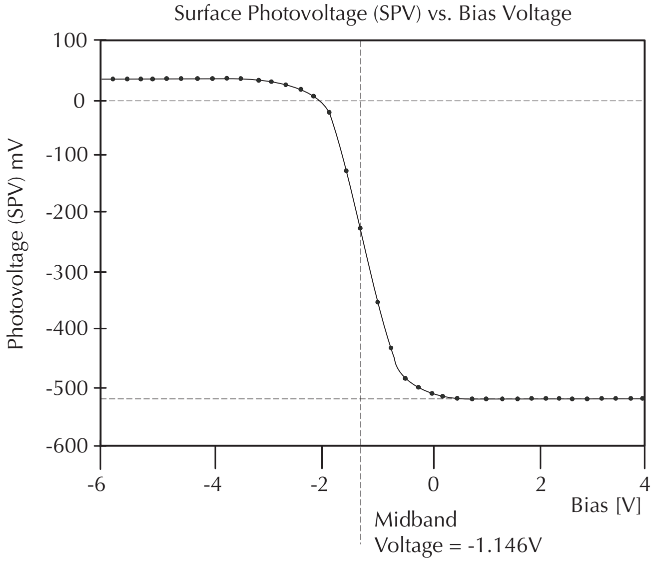
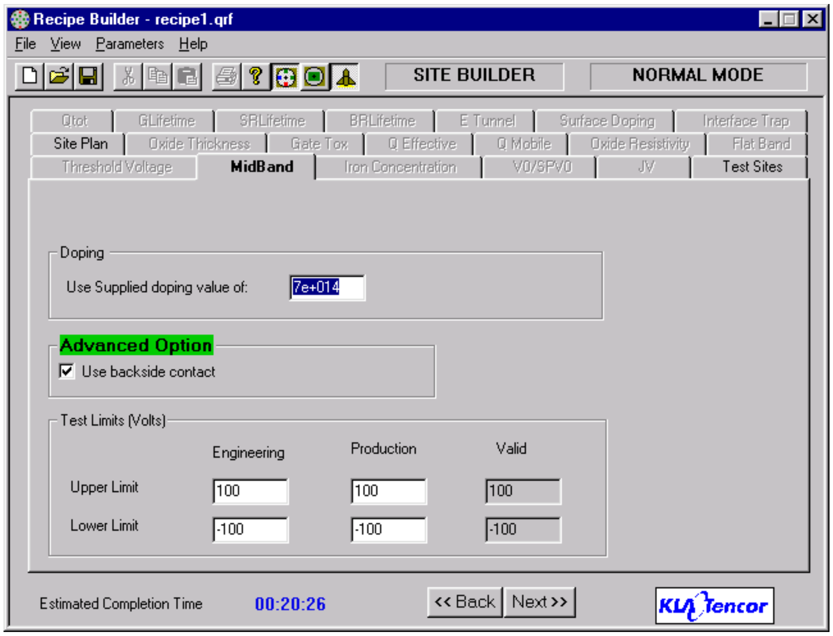


**Figure 3-27**: Midband Voltage

## Test Parameters

Figure 3-28 shows the Midband Voltage tab. Table 3-15 describes the parameters.



Doping

Use Supplied doping value of: 7e+014

**Advanced Option**

☑ Use backside contact

Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 100 | 100 | 100 |
| Lower Limit | -100 | -100 | -100 |

Estimated Completion Time 00:20:26

**Figure 3-28**: Midband Voltage, Site Test

**Table 3-15**: Midband Voltage Parameters

| Parameters | Options | Description |
|---|---|---|
| Use supplied doping value of | user-defined | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Use backside contact<br>(Advanced Option) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (volts) | See Table 3-5 |

# Interface Trap Density ($D_{it}$)

$D_{it}$ is a measure of surface states or interface traps. When the interface is grown, it may have a layer of fixed charge. Additionally, there are traps that may or may not have charge in them. The interface trap density is a measure of how many traps there are as a function of bias. Thus, the interface trap density is a measurement of the oxide/silicon interface quality. Figure 3-29 illustrates interface traps.

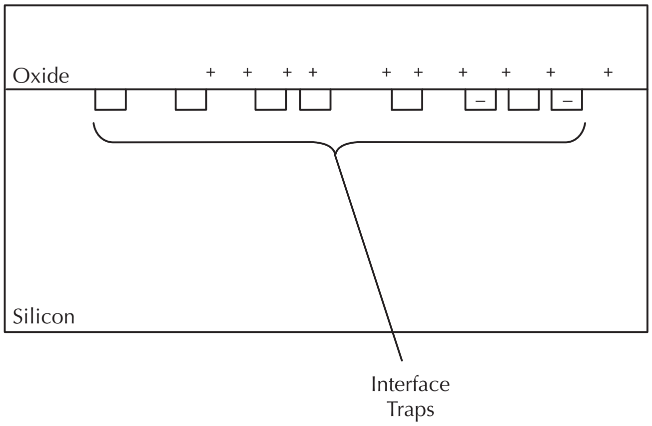


**Figure 3-29**: Interface traps

The calculation for interface trap density is

$$D_{it} = \frac{1}{q}\left[\frac{dQ}{d\Psi}(measured) - \frac{dQ}{d\Psi}(theory)\right]$$

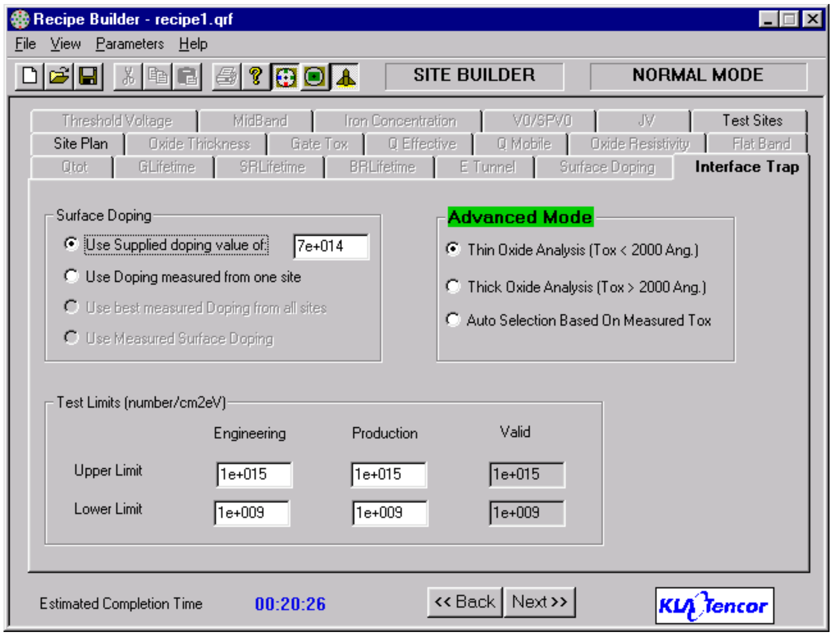
where:

$\psi$ = The voltage across the silicon bulk.

Default analysis makes use of Q-V data and the above equation. $D_{it}$ is reported at a *mid gap* condition (compare to the Advanced Mode options described in Table 3-16).

## Test Parameters

Figure 3-30 shows the Interface Trap tab. Table 3-16 describes the testing parameters.



Surface Doping

- ● Use Supplied doping value of: 7e+014
- ○ Use Doping measured from one site
- ○ Use best measured Doping from all sites
- ○ Use Measured Surface Doping

Advanced Mode

- ● Thin Oxide Analysis (Tox < 2000 Ang.)
- ○ Thick Oxide Analysis (Tox > 2000 Ang.)
- ○ Auto Selection Based On Measured Tox

Test Limits (number/cm2eV)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+015 | 1e+015 | 1e+015 |
| Lower Limit | 1e+009 | 1e+009 | 1e+009 |

Estimated Completion Time 00:20:26

**Figure 3-30**: Interface Trap Setup, Site Test

**Table 3-16**: Interface Trap Parameters

| Parameter | Options | Description |
|---|---|---|
| Surface Doping | User Supplied doping value | The software uses the value entered in this field to calculate interface trap density for all selected sites.<br>This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| | Use Doping measured from one site | Beginning with Site 1, the system makes measurements until it finds a non-bad value. The software then uses this value to calculate interface trap density at all selected sites. If all values are bad, the software uses the assumed value from the Wafer Description.<br>Use this option only if Surface Doping ***is not*** selected in the Site Plan. |

**Table 3-16**: Interface Trap Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| | Use best measured Doping from all sites | The software determines the best doping value from the *n* sites tested and use the value to calculate the interface trap density at ***all*** selected sites. (The best doping value is generally the lowest value obtained. Poor silicon quality tends to increase the reported doping value.)<br>Use only if Surface Doping ***is*** selected in the Site Plan. |
| | Use Measured Surface Doping | The software uses the measured doping value for each site to calculate the interface trap density at the site.<br>Use only if Surface Doping ***is*** selected in the Site Plan. |
| Oxide Analysis<br>(Advanced Mode) | Thin Oxide Analysis | Use for oxides with a known thickness less than 2000 Å. |
| | Thick Oxide Analysis | Use for oxides with a known thickness greater than 2000 Å. Analysis is done using Q-SPV data instead of QV data. |
| | Auto Selection Based On Measured $T_{ox}$ | The system determines best method for analysis based upon the $T_{ox}$ results. |
| Test Limits | user-defined (number/$cm^2$eV) | See Table 3-5. |

# Threshold voltage ($V_t$)

$V_t$ is the voltage at which a transistor turns on or off. $V_t$ is a function of the flatband voltage. $V_t$ becomes less accurate on wafers that exhibit high $D_{it}$. The formula used for calculating the threshold voltage is

$$V_t = V_{fb} + 2\psi_B + \frac{\sqrt{2\varepsilon_S q N_A (2\psi_B)}}{C_{OX}}$$

$$2\psi_B = \frac{2kT}{q} \ln\left(\frac{N_A}{N_i}\right)$$

$$C_{OX} = \frac{\varepsilon_{OX}}{T_{OX}}$$

where:

$\psi_B$ = The voltage across the silicon bulk.

$T_{OX}$ = The oxide thickness.

$\varepsilon_{OX}$ = The dielectric constant of the oxide.

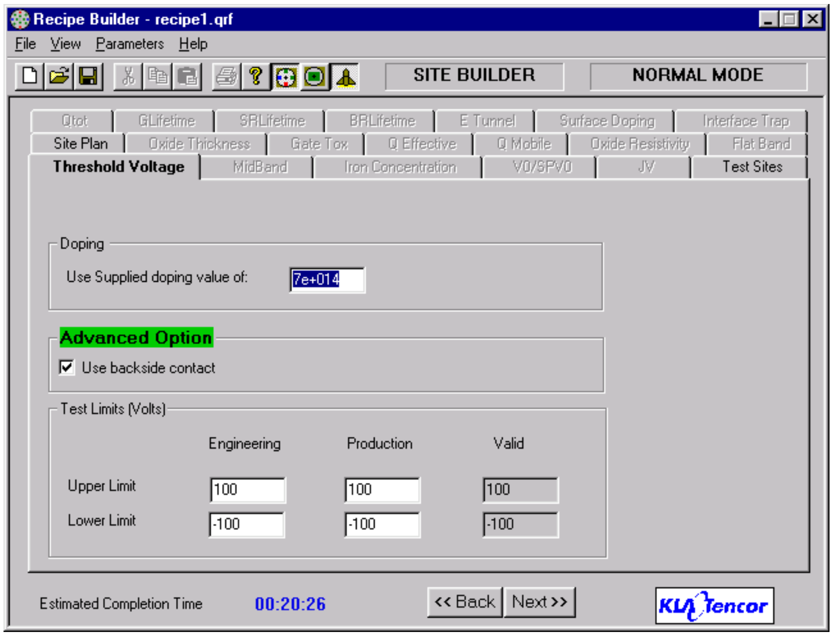
$N_A$ = The oxide doping value.

$k$ = Boltzman's constant.

$T$ = The wafer temperature.

## Test Parameters

Figure 3-31 shows the Threshold Voltage tab. Table 3-17 describes the parameters.



Doping

Use Supplied doping value of: 7e+014

Advanced Option

☑ Use backside contact

Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 100 | 100 | 100 |
| Lower Limit | -100 | -100 | -100 |

Estimated Completion Time 00:20:26

**Figure 3-31**: Threshold Voltage, Site Test

**Table 3-17**: Threshold Voltage Parameters

| Parameter | Options | Description |
|---|---|---|
| Use supplied doping value of | user-entered value | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Use backside contact<br>(Advanced Option) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (volts) | See Table 3-5. |

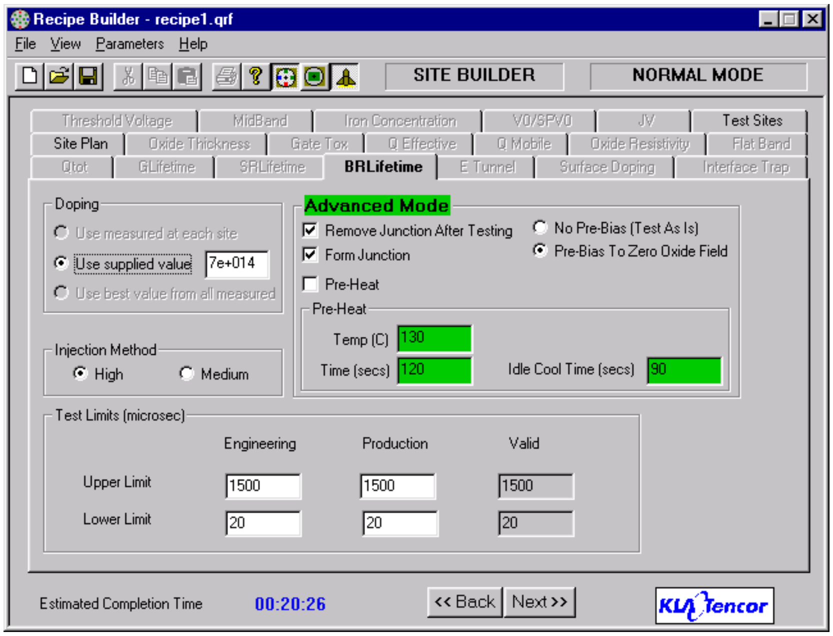
# Bulk Recombination Lifetime (BRLifetime)

The BR Lifetime is a measurement of the rate at which excess minority carriers recombines in the bulk region of the silicon. As with other lifetime measurements, it is sensitive to various sources of contamination and defects, particularly metallic contamination.

The measurement principal for BRLifetime relies on forming a field-induced junction as discussed in the Surface Doping section. Once a field-induced junction is formed, a xenon flash is turned on. This flash produces a photovoltage, which decays back to the equilibrium voltage. From the decay rate and some simple modeling, a bulk recombination lifetime can be extracted.

## Test Parameters

Figure 3-32 shows the BRLifetime tab. Table 3-18 describes the test parameters.



Doping
○ Use measured at each site
● Use supplied value 7e+014
○ Use best value from all measured

Injection Method
● High ○ Medium

Advanced Mode
☑ Remove Junction After Testing
☑ Form Junction
☐ Pre-Heat
○ No Pre-Bias (Test As Is)
● Pre-Bias To Zero Oxide Field

Pre-Heat
Temp (C) 130
Time (secs) 120
Idle Cool Time (secs) 90

Test Limits (microsec)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1500 | 1500 | 1500 |
| Lower Limit | 20 | 20 | 20 |

Estimated Completion Time 00:20:26

**Figure 3-32**: Bulk Recombination Lifetime, Site Test

**Table 3-18**: Bulk Recombination Lifetime Parameters

| Parameter | Options | Description |
|---|---|---|
| Doping | Use calculated at each site | The doping from each site is used for the lifetime calculation. |
| | Use supplied value | The software uses the value entered in this field to calculate lifetime for all selected sites.<br>This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| | Use best value from all measured | The software determines the best doping value from the *n* sites tested and use the value to calculate the lifetime at ***all*** selected sites. (The best doping value is generally the lowest value obtained. Poor silicon quality tends to increase the reported doping value.) |
| Injection Method | High | The silicon is strongly forward biased by a broadband light source. The high-injection condition causes many photo-generated carriers to diffuse deep into the bulk of the silicon. |
| | Medium | |
| Remove Junction After Testing | checked or not checked | This option must be used for repeated measurements at the same site and is checked by default.<br>This option is not necessary if repeated measurements not made. Deselecting this option saves test time. |
| Form Junction | | |

**Table 3-18**: Bulk Recombination Lifetime Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Pre-Bias<br>(Advanced Mode) | No Pre-Bias (Test As Is)<br>Pre-Bias To Zero Oxide Field | Pre-Bias prepares the site by biasing it to zero volts before forming the junction.<br>This option is not necessary for wafers with low incoming surface charge. Selecting No Pre-Bias saves test time. |
| PreHeat<br>(Advanced Mode) | Temp (°C) between 50 and 275<br>Time (secs) between 60 and 900<br>Idle Cool-Time (secs) between 90 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Test Limits | user-defined (microseconds) | See Table 3-5. Limits should consider the Injection Method |

# Total Charge ($Q_{tot}$)

$Q_{tot}$ is a measurement of the net or total charge present at a measurement site. $Q_{tot}$ includes any charge at the Si/SiO$_2$ interface, any charge in the oxide, and any charge on the surface of the oxide. $Q_{tot}$ does not discriminate as to where the charge is, as in a $V_{fb}$ measurement, but sees all charge present.

$$Q_{tot} = Q_{surf} + Q_m + Q_f + Q_{it} + Q_{ot}$$

where:

$Q_{tot}$ = The total charge present at the measurement site.

$Q_{surf}$ = The charge on the surface of the oxide.

$Q_m$ = The mobile charge (usually Na+ or K+) usually found trapped at the air/ oxide interface or at the silicon/oxide interface. It may also be distributed throughout the oxide.

$Q_f$ = A layer of fixed charge, at the silicon/oxide interface, associated with the growth of an oxide.

$Q_{it}$ = The charge that may be transferred from the silicon/oxide interface into the bulk silicon depending on bias.

$Q_{ot}$ = The electrons or holes trapped in the oxide bulk.

Figure 3-33 illustrates Total Charge.

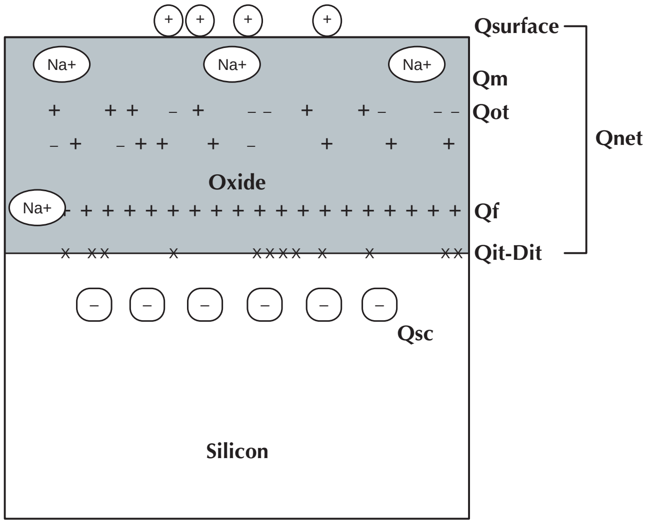


**Figure 3-33**: Total Charge

The data acquisition for $Q_{tot}$ is performed in a manner identical to the $V_{fb}$ measurement (see previous section).Unlike a $V_{fb}$ measurement, no backside contact is needed for accurate results.

During the $V_{fb}$ analysis, $V_{fb}$ was identified as being the point at which the photovoltage went to approximately 0. In a similar manner, $Q_{tot}$ can be calculated by merely looking at the Q-axis when $V_{fb}$ is reached. The Quantox system keeps track of how much charge was applied during the measurement data acquisition of $V_{fb}$. The $Q_{tot}$ is merely the negative of the charge applied to get to $V_{fb}$.

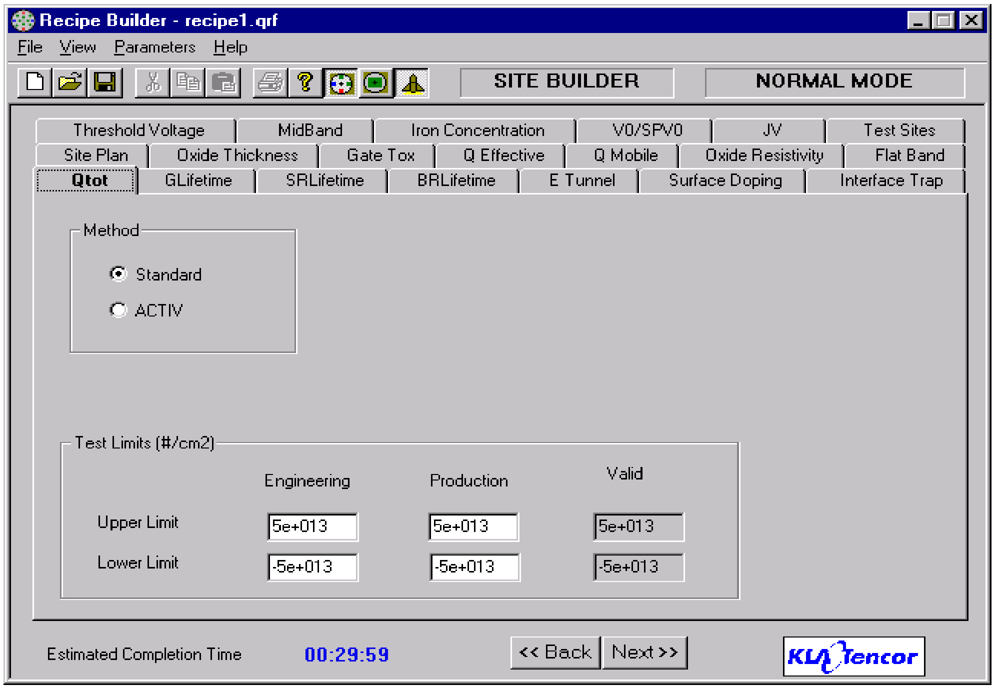
$$Q_{tot} = -(Qapplied\_to\_reach\_V_{fb})$$

Because $Q_{tot}$ is determined by measuring the charge necessary to get to $V_{fb}$, no modeling is necessary (as would be needed to determine $Q_{tot}$ from the SPV) and the measurement is extremely accurate and independent of any theoretical models.

Because $Q_{tot}$ is measured by adding charge until $V_{fb}$ is reached, the measurement cannot be repeated in a manner similar to other measurements because the charge on the surface of the oxide is changed in the process of making the measurement.

## Test Parameters

Figure 3-34 shows the $Q_{tot}$ tab. Test Limits (#/cm$^2$) are the only parameters to be set (see Table 3-5). In the Method field, choose either Standard or ACTIV, which directs the software to estimate $V_{fb}$ from the Vs value at the SPV pre-bias condition.



Method
● Standard
○ ACTIV

Test Limits (#/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 5e+013 | 5e+013 | 5e+013 |
| Lower Limit | -5e+013 | -5e+013 | -5e+013 |

Estimated Completion Time 00:29:59

**Figure 3-34**: Total Charge Setup, Site Test

# Generation Lifetime (GLifetime)

GLifetime is a measurement of the rate at which minority carriers are generated when there is a deficit of carriers. As with other lifetime measurements, Generation Lifetime is sensitive to metallic contamination. In addition, this measurement is particularly sensitive to physical defects in the silicon. The Quantox measurement of generation lifetime is very similar to the generation lifetime measured by a CV based C-t Zerbst measurement.

Data acquisition for the generation lifetime measurement proceeds in a manner identical to that of the doping measurement (see Surface Doping). In both of these measurements, a field induced junction is formed and the silicon is pulsed into a non-equilibrium state by quickly applying a packet of charge via a corona source.

The analysis of the data proceeds in a manner similar to doping with the addition of one other experimentally determined parameter. The initial rate at which the voltage is decaying is quantified by the slope of the voltage-vs.-time plot, *dV/dt*. Qualitatively, for shorter lifetimes, the decay is quicker and the slope is higher in magnitude.

The generation lifetime can be determined from this slope by using the following expression.

$$GLifetime = (1/\varepsilon_{si})qn_iW_{dd}((W_{dd}-W_{inv})(1/(dV/dt))$$

where:

$dV/dt$ = The initial slope of the $V$ vs. $t$ data.

$\varepsilon_{si}$ = The dielectric constant of the silicon.

$q$ = The charge on an electron.

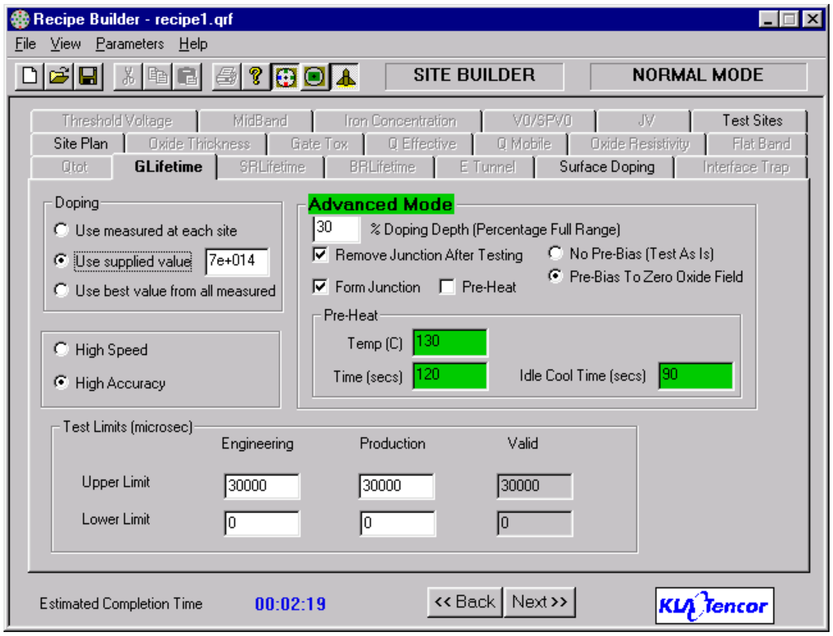
$W_{dd}$ = The maximum depth pulsed to during the deep depletion pulse.

$W_{inv}$ = The equilibrium depletion depth.

$n_i$ = The intrinsic carrier concentration of the semiconductor.

## Test Parameters

Figure 3-35 shows the Generation Lifetime tab. Table 3-19 describes the parameters.



Doping
- ○ Use measured at each site
- ● Use supplied value 7e+014
- ○ Use best value from all measured

- ○ High Speed
- ● High Accuracy

Advanced Mode
- 30 % Doping Depth (Percentage Full Range)
- ☑ Remove Junction After Testing
- ☑ Form Junction
- ☐ Pre-Heat
- ○ No Pre-Bias (Test As Is)
- ● Pre-Bias To Zero Oxide Field

Pre-Heat
- Temp (C) 130
- Time (secs) 120
- Idle Cool Time (secs) 90

Test Limits (microsec)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 30000 | 30000 | 30000 |
| Lower Limit | 0 | 0 | 0 |

Estimated Completion Time 00:02:19

**Figure 3-35**: Generation Lifetime, Site Test

**Table 3-19**: Generation Lifetime Parameters

| Parameter | Options | Description |
|---|---|---|
| Doping | Use calculated at each site | The doping from each site is used for the lifetime calculation. |
| | Use supplied value | The software uses the value entered in this field to calculate lifetime for all selected sites.<br>This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |

**Table 3-19**: Generation Lifetime Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| | Use best value from all measured | The software determines the best doping value from the *n* sites tested and uses the value to calculate the lifetime at ***all*** selected sites. (The best doping value is generally the lowest value obtained. Poor silicon quality tends to increase the reported doping value.) |
| (test method) | High Speed | The diameter of the field-induced junction created for the measurement is assumed. |
| | High Accuracy | The diameter of the field-induced junction is measured. High Accuracy is the default setting. |
| % Doping Depth (Percentage Full Range)<br>(Advanced Mode) | user-defined | Controls the depth to which the doping measurement is made. Increasing the percentage causes the doping measurement to sample deeper into the silicon.<br>The same % Doping Depth value pulses to greater depths on wafers with lower doping. The Report Generator prints out the actual depth to which the doping is measured. |
| Remove Junction After Testing | checked or not checked | This option must be used for repeated measurements at the same site and is checked by default.<br>This option is not necessary if repeated measurements are not made. Deselecting this option saves test time. |

**Table 3-19**: Generation Lifetime Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Form Junction | | |
| PreHeat<br>(Advanced Mode) | Temp (°C) between 50 and 275<br>Time (secs) between 60 and 900<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 90 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Pre-Bias<br>(Advanced Mode) | No Pre-Bias (Test As Is)<br>Pre-Bias To Zero Oxide Field | Pre-Bias prepares the site by biasing it to zero volts before forming the junction.<br>This option is not necessary for wafers with low incoming surface charge. Selecting No Pre-Bias saves test time. |
| Test Limits | user-defined (microseconds) | See Table 3-5 |

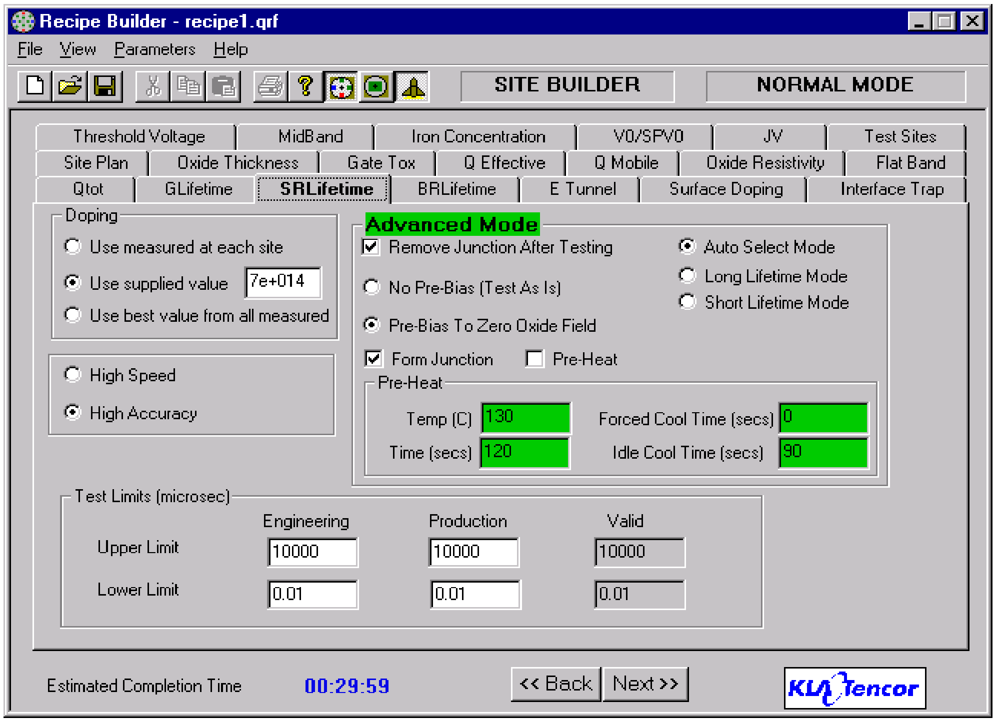
# Surface Recombination Lifetime (SRLifetime)

SRLifetime is a measurement of the rate at which excess minority carriers recombine in the region of the silicon near to the surface. As with other lifetime measurements, it is sensitive to various sources of contamination and defects, particularly metallic contamination. Because it is a near-surface measurement, it measures the quality of the silicon in the region where devices are being made and does not suffer from misleading results from bulk defects such as oxygen precipitates.

The measurement principle for SRLifetime relies on forming a field-induced junction as discussed in the Surface Doping section. Once a field induced junction is formed, an LED is turned on. The light emitted by the LED produces a photovoltage that decays back to the equilibrium voltage as the light source is turned off. From the decay rate and some simple modeling, a surface recombination lifetime can be extracted.

## Test Parameters

Figure 3-36 shows the SRLifetime tab. Table 3-20 describes the parameters.



Doping

○ Use measured at each site
● Use supplied value 7e+014
○ Use best value from all measured

○ High Speed
● High Accuracy

Advanced Mode

☑ Remove Junction After Testing
○ No Pre-Bias (Test As Is)
● Pre-Bias To Zero Oxide Field
☑ Form Junction ☐ Pre-Heat

● Auto Select Mode
○ Long Lifetime Mode
○ Short Lifetime Mode

Pre-Heat

Temp (C) 130
Time (secs) 120
Forced Cool Time (secs) 0
Idle Cool Time (secs) 90

Test Limits (microsec)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 10000 | 10000 | 10000 |
| Lower Limit | 0.01 | 0.01 | 0.01 |

Estimated Completion Time 00:29:59

**Figure 3-36**: Surface Recombination Lifetime, Site Test

**Table 3-20**: Surface Recombination Lifetime Parameters

| Parameter | Options | Description |
|---|---|---|
| Doping | Use calculated at each site | The doping from each site is used for the lifetime calculation. |
| | Use supplied value | The software uses the value entered in this field to calculate lifetime for all selected sites.<br>This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| | Use best value from all measured | The software determines the best doping value from the *n* sites tested and use the value to calculate the lifetime at ***all*** selected sites. (The best doping value is generally the lowest value obtained. Poor silicon quality tends to increase the reported doping value.) |
| (test method) | High Speed | The diameter of the field-induced junction created for the measurement is assumed. |
| | High Accuracy | The diameter of the field-induced junction is measured. High Accuracy is the default setting. |
| Remove Junction After Testing | checked or not checked | This option must be used for repeated measurements at the same site and is checked by default.<br>This option is not necessary if repeated measurements are not made. Deselecting this option saves test time. |
| (monitoring method) | Auto Select Mode | The system determines the appropriate monitoring method. |
| | Long Lifetime Mode | Decay of the forward-biased junction is monitored via the surface potential. |

**Table 3-20**: Surface Recombination Lifetime Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| (monitoring method, continued) | Short Lifetime Mode | Decay of the forward-biased junction is monitored via the SPV decay. |
| Pre-Bias<br>(Advanced Mode) | No Pre-Bias (Test As Is)<br>Pre-Bias To Zero Oxide Field | Pre-Bias prepares the site by biasing it to zero volts before forming the junction.<br>This option is not necessary for wafers with low incoming surface charge. Selecting No Pre-Bias saves test time. |
| Form Junction | | |
| PreHeat (Advanced Mode) | Temp (°C) between 50 and 275<br>Time (secs) between 60 and 900<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 90 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Test Limits | user-defined (microseconds) | See Table 3-5. |

# Tunneling Field ($E_{tunnel}$)

$E_{tunnel}$ provides an indication of the oxide integrity and quality in a manner similar to more traditional breakdown measurements. In this measurement, what is actually measured is the electric field in the oxide when tunneling becomes dominant.

The Quantox system performs this measurement by applying a large amount of charge to the oxide site under test. Typically, as more and more charge is applied on the surface of an oxide, more and more voltage is developed on the surface of the oxide according to the relationship.

$$Q_{surf} = C_{ox} V_{ox}$$

where:

$V_{ox}$ = The resultant voltage across the oxide.

$C_{ox}$ = The capacitance of oxide (related to thickness).

$Q_{surf}$ = The charge applied to the surface.

All oxides eventually reach a point where as more and more charge is applied, the resulting voltage deviates from this simple relationship. In the Quantox system, a point is eventually reached where as more and more charge is applied, the voltage across the oxide, $V_{ox,}$ reaches some final equilibrium value, $V_{final}$.

This final voltage is primarily determined by when the oxide starts to conduct current via a "tunneling" mechanism, hence the name "tunneling field". For most oxides this is a Fowler-Nordheim tunneling mechanism.

The following equation is used to calculate the tunneling field.

$$E_{tunnel} = V_{final} / T_{ox}$$

where:

$V_{final}$ = The final limiting surface voltage.

$T_{ox}$ = The oxide thickness.

By converting from $V_{final}$ to an electric field, a parameter which is more or less independent of oxide thickness is derived.

---

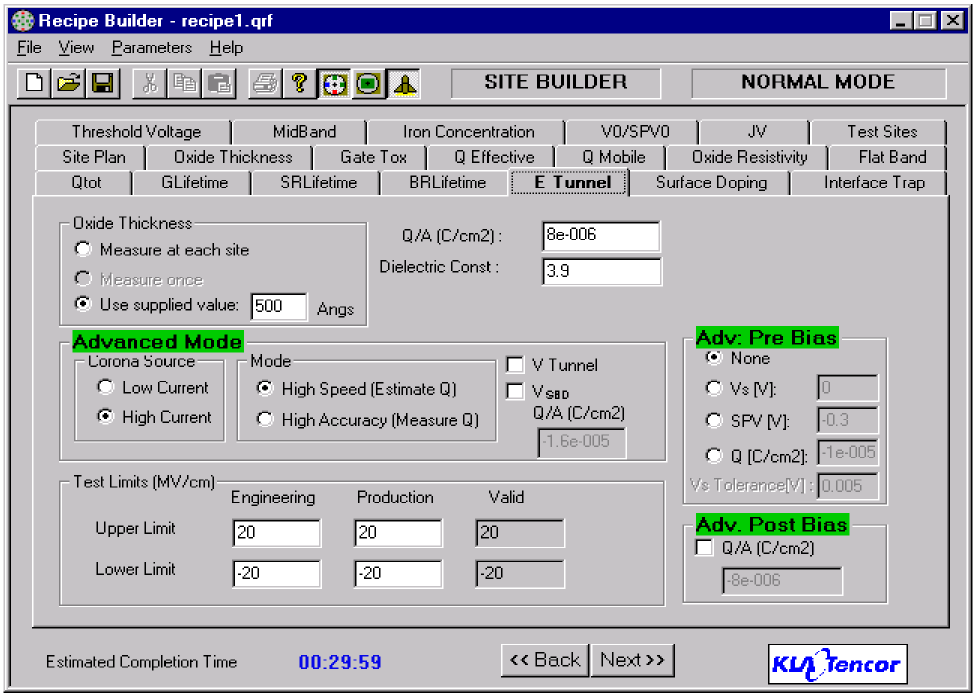
**CAUTION**

The $E_{tunnel}$ test should not be performed on wafers with oxides or dielectric thicker than 700 Å. This is because Quantox Kelvin probes can only support up to ±100 V. No machine damage occurs, but the test results are incorrect. This limitation is also true for the $E_{tunnel}$ map-based measurement.

---

## Test Parameters

Figure 3-37 shows the E Tunnel tab. Table 3-21 describes the test parameters.



Oxide Thickness
○ Measure at each site
○ Measure once
● Use supplied value: 500 Angs

Q/A (C/cm2) : 8e-006
Dielectric Const : 3.9

Advanced Mode
Corona Source
○ Low Current
● High Current
Mode
● High Speed (Estimate Q)
○ High Accuracy (Measure Q)
☐ V Tunnel
☐ $V_{SBD}$
Q/A (C/cm2) -1.6e-005

Adv. Pre Bias
● None
○ Vs [V]: 0
○ SPV [V]: -0.3
○ Q [C/cm2]: -1e-005
Vs Tolerance[V] : 0.005

Adv. Post Bias
☐ Q/A (C/cm2) -8e-006

Test Limits (MV/cm)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 20 | 20 | 20 |
| Lower Limit | -20 | -20 | -20 |

Estimated Completion Time 00:29:59

**Figure 3-37**: E Tunnel, Site Test

**Table 3-21**: E Tunnel Parameters

| Parameter | Options | Description |
|---|---|---|
| Oxide Thickness | Measure at each site | The thickness test are performed as part of the Tunneling Field test.<br>(Selecting the Oxide Thickness test in the Site Plan makes it easier to access QV data later.) |

**Table 3-21**: E Tunnel Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| | Use supplied value (15 to 10,000Å). | The system uses the value entered in the oxide thickness field.<br>If Tunneling Field is the only test selected, supplying the oxide thickness can significantly reduce measurement time.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Q/A (C/cm2) | user-defined<br>Default value is +8.0 E-6 Coulomb/cm$^2$ for a P-type wafer. | The charge per unit area used to measure the tunneling field. |
| Dielectric Const | user-defined value | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Post Bias Q/A [C/cm2] | Selected (default)<br>Not Selected | Allows you to define the Post Bias charge per unit area. This charge is for Final Post Bias. It is put on after the second charge of Diff. Vtunnel measurement.<br>Default: –Q/A value.<br>The default value is –8-6 Q/A (C/cm2).<br>This value doesn't change automatically with the charge(s) used for Tunneling measurements (VTunnel, ETunnel, Pos., Neg., Diff.).<br>When using an old recipe created with "Remove Blanket After Measurement," check this value after loading the recipe. |
| Corona Source<br>(Advanced Mode) | Low Current<br>High Current | High Current is the default setting. Selecting Low Current increases measurement time by a factor of nearly 10. |

**Table 3-21**: E Tunnel Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Mode<br>(Advanced Mode) | High Speed (Estimate Q)<br>High Accuracy (Measure Q) | High Speed is the default setting. Selecting High Accuracy increases measurement time by about 30%. |
| V Tunnel<br>(Advanced Mode) | checked or not checked | |
| Differential Mode Q/A [C/cm2] | Selected<br>Not Selected (default) | Allows you to define the Differential Mode charge per unit area.<br>Default: 2x Q/A field limits.<br>If Differential Mode is selected, High Current is the default Corona Source. |
| $V_{SBD}$ | Selected<br>Not Selected (default) | Enables you to define soft breakdown voltage, $V_{SBD}$. If you select $V_{SBD}$, High Current is the default Corona Source. |
| Advanced Pre Bias | None (default)<br>Vs<br>SPV<br>Q | Values:<br>V-based:<br>-100 <Vs <100<br>SPV-based:<br>-1 <SPV <1<br>Q-based:<br>MIN_Q < Q < MAX_Q<br>(from ManSweep entries). |
| Advanced Post Bias<br>Q/A[C/cm2] | Selected<br>Not Selected (default) | Replaces the Remove Blanket After Measurement checkbox. Enables you to define the Post Bias charge per unit area. This charge is applied at the final step.<br>The default value is -8e-6 C/cm2.<br>Note Software always sets the post bias value to -83-6 C/cm2. When loading an old recipe with Remove Blanket After Measurement, you need to correct the post bias value if you do not want this default. |

**Table 3-21**: E Tunnel Parameters (Continued)

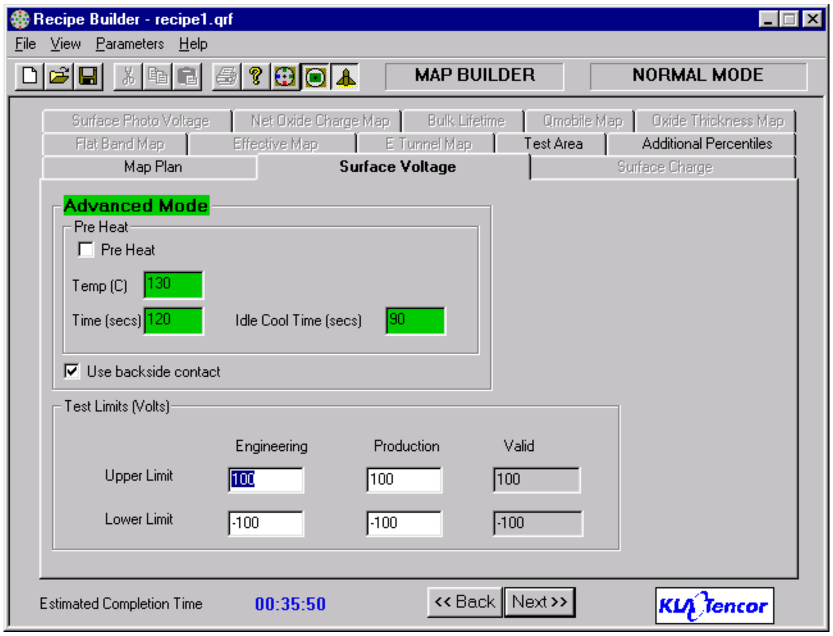
| Parameter | Options | Description |
|---|---|---|
| Test Limits | user-defined (MV/cm) | See Table 3-5. |

# Surface Voltage Map ($V_s$)

$V_s$ is a measure of the voltage on the surface of the oxide. This voltage is the sum of the voltage across the oxide plus the voltage across the silicon bulk. The voltage across the silicon bulk tends to be very small, therefore the surface voltage is essentially the voltage across the oxide layer. A surface voltage map is constructed by moving the wafer under the Kelvin probe and taking readings at various locations. These measurement points are plotted on a three-dimensional grid. The map shows the distribution of surface voltage graphically.

## Test Parameters

Figure 3-38 shows the Surface Voltage tab. Table 3-22 describes the test parameters.



**Advanced Mode**

Pre Heat

☐ Pre Heat

Temp (C) 130

Time (secs) 120

Idle Cool Time (secs) 90

☑ Use backside contact

Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 100 | 100 | 100 |
| Lower Limit | -100 | -100 | -100 |

Estimated Completion Time 00:35:50

**Figure 3-38**: Surface Voltage, Map Test

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**NOTE**

If a relative map is desired, the backside contact is not necessary. However, for absolute maps, the backside contact must be used.

---

**Table 3-22**: Surface Voltage Parameters

| Parameters | Options | Description |
|---|---|---|
| PreHeat<br>(Advanced Mode) | Temp (°C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Use backside contact<br>(Advanced Option) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (Volts) | See Table 3-5. |

# Surface Charge Map ($Q_{surf}$)

$Q_{surf}$ is a measure of the charge on the surface of the oxide. The $Q_{surf}$ map shows the distribution of the surface charge graphically. The map is constructed using the surface voltage, oxide thickness, and the formula:

$$Q_{surf} = C_{ox}V_{ox}$$

where:

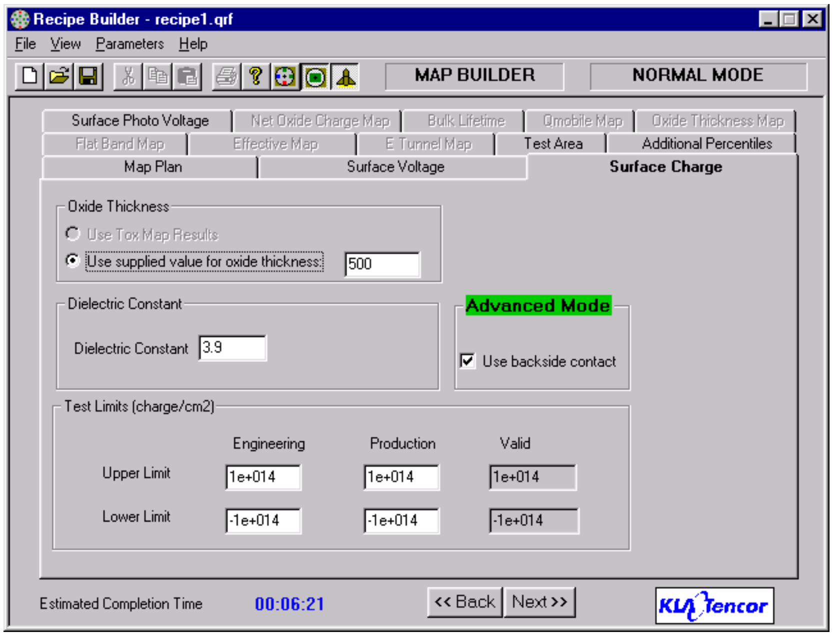
$Q_{surf}$ = The charge applied to the surface.

$C_{ox}$ = The capacitance of oxide (related to thickness).

$V_{ox}$ = The resultant voltage across the oxide.

## Test Parameters

Figure 3-39 shows the Surface Charge tab. Table 3-23 describes the test parameters.



Oxide Thickness

○ Use Tox Map Results

● Use supplied value for oxide thickness: 500

Dielectric Constant

Dielectric Constant 3.9

Advanced Mode

☑ Use backside contact

Test Limits (charge/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+014 | 1e+014 | 1e+014 |
| Lower Limit | -1e+014 | -1e+014 | -1e+014 |

Estimated Completion Time 00:06:21

**Figure 3-39**: Surface Charge, Map Test

**Table 3-23**: Surface Charge Parameters

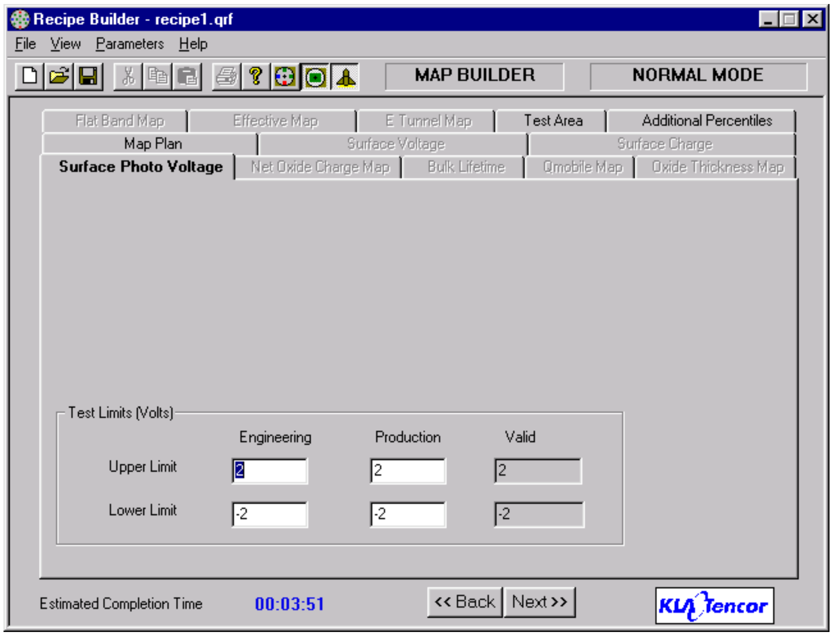
| Parameter | Options | Description |
|---|---|---|
| Oxide Thickness | Use $T_{ox}$ Map Results (requires selection of $T_{ox}$ Map in Map Plan) | The system uses the $T_{ox}$ map results in calculating Surface Charge. |
| | Use supplied value for oxide thickness | The system uses the value entered in the field.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Dielectric Constant | user-defined value | This field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Use backside contact<br>(Advanced Mode) | checked or not-checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact is greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (charge/$cm^2$) | See Table 3-5. |

# Surface Photovoltage Map (SPV)

SPV is a measure of the voltage drop in the silicon that is performed by illuminating the sample with a light source. SPV data can be used as a measure of the net charge in an oxide-semiconductor system. If you select a box to calibrate the SPV data, the SPV axis can be replotted as $Q_{net}$ data using some additional test data.

## Test Parameters

Figure 3-40 shows the Surface Photovoltage tab. Test Limits (Volts) are the only parameters to be set.



Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 2 | 2 | 2 |
| Lower Limit | -2 | -2 | -2 |

Estimated Completion Time 00:03:51

**Figure 3-40**: Surface Photovoltage, Map Test

# Net Oxide Charge Map ($Q_{net}$)

$Q_{net}$ maps provide an excellent tool for *fingerprinting* process and equipment related problems. Data acquisition for the $Q_{net}$ map measurement is identical to that of an SPV map and does not require any additional test time.

Any charge present in the dielectric (oxide) material on a semiconductor is imaged in the silicon and produces a corresponding field and voltage drop at the surface of the silicon. This charge consists of all charges present on the surface of the dielectric, the dielectric-silicon interface, and throughout the bulk of the dielectric. This is typically expressed by the sum of: $Q_{surf} + Q_m + Q_f + Q_{ot}$. See "Total Charge (Qtot)" on page 3-70 for a description of the various charge components.

By pulsing a strong light source and measuring the resulting photovoltage, the Quantox measurement system can accurately determine the SPV at the surface of the silicon. Because the Quantox uses an extremely strong light source, the resulting photovoltage is not a function of the illumination intensity but instead is limited by the total band-bending at the surface of the silicon. The resulting photovoltage can be reported by itself as an SPV map, however it is possible to estimate the charge present which would have caused the resulting photovoltage. The Oxide Charge Map does this conversion and can be thought of as another way of viewing SPV map data.

Unlike the more accurate site-based $Q_{tot}$ charge measurement, the map measurement assumes a theoretical model for the expected relationship between SPV and charge. By assuming a negligible interface trap charge density ($D_{it}$) and assuming a doping of 7E14, the measured SPV can be converted into an Oxide Charge Map [charge/cm^2]. The relationship used for this conversion is:

$$Q = \pm\frac{1}{q}\frac{\sqrt{2E_{si}}}{B}\sqrt{\frac{qBp_0}{E_{si}}}\sqrt{(e^{-BV}+BV-1)+\frac{n_0}{p_0}(e^{BV}-BV-1)}$$

where:

*V* is approximated by the negative of the measured SPV with a slight empirical correction. The plus sign is used for V>0, and the negative sign for V<0.

$q$ = the charge of an electron.

$B$ = $q/kT$, where $T$ is the temperature in Kelvin and $k$ is Boltzman's constant.

For P-type wafer: $p_0 = 7E14$, $n_0 = n_i * n_i / p_0$ (wafer type obtained from recipe).

For N-type wafer: $n_0 = 7E14$, $p_0 = n_i * n_i / n_0$ (wafer type obtained from recipe).

$n_i$ is the intrinsic carrier concentration for silicon.

## Test Parameters

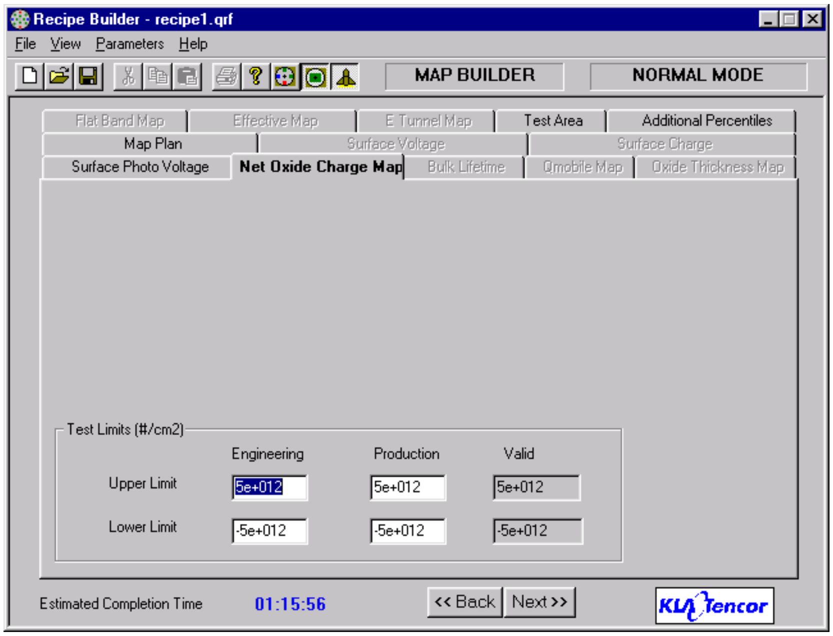
Figure 3-41 shows the Net Oxide Charge Map tab. Test Limits (charge/$cm^2$) are the only parameters to be set (see Table 3-5).

---

**CAUTION**

Make sure that the correct wafer conductivity type (P or N) is selected in the Wafer Description (Parameters menu).

---



Test Limits (#/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 5e+012 | 5e+012 | 5e+012 |
| Lower Limit | -5e+012 | -5e+012 | -5e+012 |

Estimated Completion Time 01:15:56

**Figure 3-41**: Net Oxide Charge, Map Test

# Bulk Lifetime Map

Like other lifetime measurements, Bulk Lifetime maps monitor the quality of the silicon in a wafer. Metals are a particularly problematic source of "lifetime killers" however excess oxygen, interstitial defects, point defects, and a variety of other mechanisms can also lead to degraded silicon quality and lowered lifetimes. The Quantox Bulk Lifetime Map is based on a bulk recombination lifetime measurement performed at a high injection level. This particular type of lifetime measurement is sensitive to contaminants over a wide range of energy levels. Because the data is in the form of maps, this measurement is particularly useful for identifying non-uniform contamination sources. Typical applications involve identifying sources of contamination such as wafer handling mechanisms, wafer wands, and boat contact points with wafers. Because of some tradeoffs in performance, maps produce a less accurate result than the site based measurement and should be considered a more qualitative means of identifying relative variation across a wafer by looking for fingerprints of equipment or processing problems.

Bulk Lifetime map data acquisition is performed in a manner identical to the site based Bulk Lifetime measurement except that individual field induced junctions are not formed. Instead, the entire wafer is blanketed with corona using a corona source in the Quantox. This blanket corona puts the entire surface of the wafer into an inversion condition which is needed for reliable measurements.

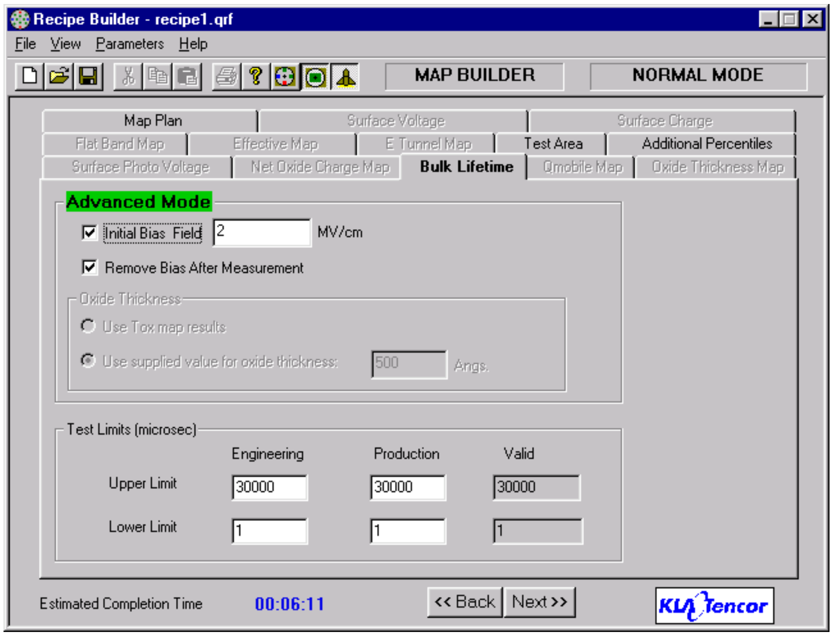
Data acquisition consists of scanning the wafer under a sensor while pulsing a light source at each *xy*-location on the wafer and capturing an SPV vs. time decay curve. The SPV decay curve at each location is analyzed to obtain the high-injection lifetime level in a method identical to the site based high-injection lifetime measurement. See the discussion in the bulk lifetime site measurement section for more details.

## Test Parameters

Figure 3-42 shows a Bulk Lifetime Map tab. Table 3-24 describes the test parameters.

**CAUTION**

Make sure that the correct wafer conductivity type (P or N) is selected in the Wafer Description (Parameters menu).



Advanced Mode

☑ Initial Bias Field 2 MV/cm

☑ Remove Bias After Measurement

Oxide Thickness

○ Use Tox map results

● Use supplied value for oxide thickness: 500 Angs.

Test Limits (microsec)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 30000 | 30000 | 30000 |
| Lower Limit | 1 | 1 | 1 |

Estimated Completion Time 00:06:11

**Figure 3-42**: Bulk Lifetime, Map Test

**Table 3-24**: Bulk Lifetime Parameters

| Parameters | Options | Description |
|---|---|---|
| Initial Bias Field<br>(Advanced Mode) | user-defined (MV/cm) | A blanket layer of corona is required for bulk lifetime maps. Enter a value for the desired electric field in units of MV/cm.<br>Do not enter a signed value for the field, because the polarity is determined by the wafer type (entered in the Wafer Description).<br>The default value is 2 MV/cm |
| Remove Bias After Measurement | checked or not checked | Check to remove the bias after testing. |
| Test Limits | user-defined (microseconds) | See Table 3-5 |

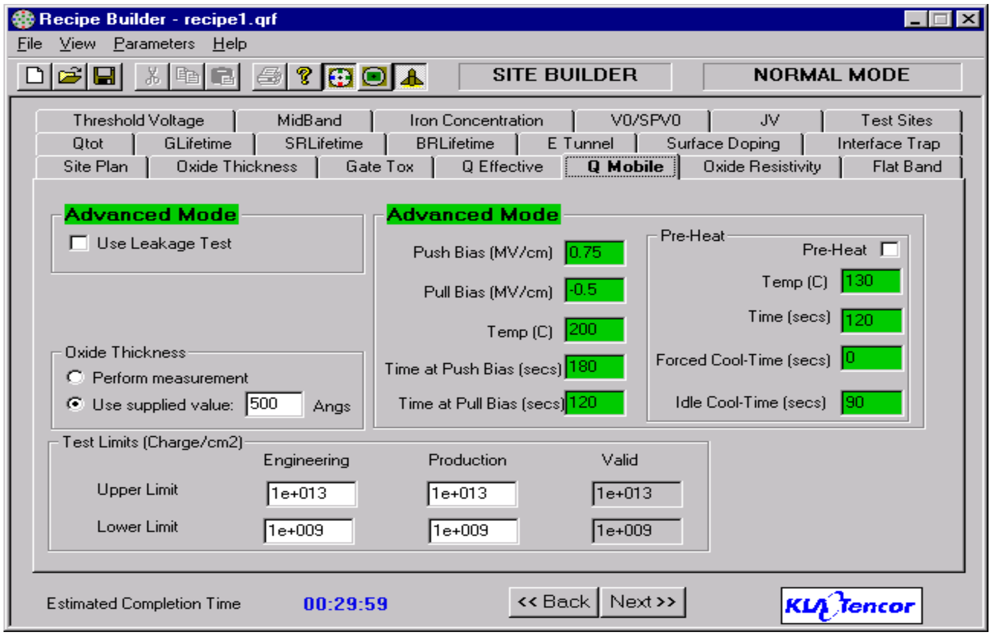
# Mobile Charge Map ($Q_{mobile}$)

Map-based $Q_{mobile}$ measurements, in principle, are closely related to site-based measurements with the exception that the map measurement uses whole wafer blanket corona charging. To begin, a positive blanket charge is applied to the wafer. This is followed by a heat cycle which moves all of the mobile charge to its starting position at the Si/SiO2 interface. Next, a negative blanket charge is deposited, and the surface voltage is then mapped. This sequence si followed by a second heat cycle which moves the mobile charge back to the Si O2/Air interface. Once all of the mobile charge is moved to this interface, the surface voltage is again mapped. The mobile charge is then calculated, based on the change is surface voltage between the two surface voltage maps.

$Q_{mobile}$ Map relies heavily on the ability of the corona blanket to provide a uniform charge. Any deviations in the blanket result in $Q_{mobile}$ noise. The quality and thickness of the oxide also influence $Q_{mobile}$ Map. With thinner oxides, sensitivity and accuracy of the $Q_{mobile}$ measurement is reduced.

## Test Parameters

Figure 3-43 shows the $Q_{mobile}$ tab. Table 3-25 describes the test parameters.



Advanced Mode

☐ Use Leakage Test

Oxide Thickness

○ Perform measurement

● Use supplied value: 500 Angs

Advanced Mode

Push Bias (MV/cm) 0.75

Pull Bias (MV/cm) -0.5

Temp (C) 200

Time at Push Bias (secs) 180

Time at Pull Bias (secs) 120

Pre-Heat

Pre-Heat ☐

Temp (C) 130

Time (secs) 120

Forced Cool-Time (secs) 0

Idle Cool-Time (secs) 90

Test Limits (Charge/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+013 | 1e+013 | 1e+013 |
| Lower Limit | 1e+009 | 1e+009 | 1e+009 |

Estimated Completion Time 00:29:59

**Figure 3-43**: $Q_{mobile}$ Tab

**NOTE**

Do not change the Advanced Mode defaults without consulting your KLA-Tencor Applications representative. Accuracy and precision may suffer.

**Table 3-25**: $Q_{mobile}$ Parameters

| Parameter | Options | Description |
|---|---|---|
| Use Leakage Test (Advanced Mode) | checked or<br>not checked | Tests for leaky oxide |
| Push and Pull Bias (Advanced Mode) | user-defined values | Specifies individual Push and Pull bias (MV/cm), heating temperature (°C), and the time at biases (seconds) |
| PreHeat (Advanced Mode) | Temp (C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |
| Oxide Thickness | Use $T_{ox}$ Map Results (requires selection of $T_{ox}$ Map in Map Plan) | The system uses the $T_{ox}$ map results in calculating Mobile Charge. |
| | Use supplied value | The system uses the value entered in the oxide thickness field<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location changes the value in all. |
| Test Limits | user-defined (charge/$cm^2$) | See Table 3-5. |

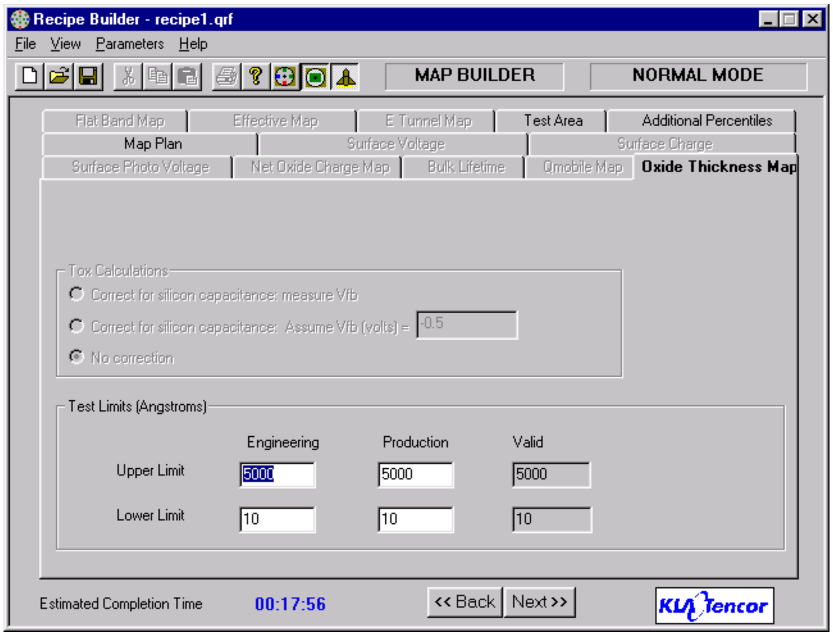
# Oxide Thickness Map ($T_{ox}$)

As with site-based oxide thickness measurements, the $T_{ox}$ map measurement is obtained by plotting Q versus V. For map measurements, the amount of charge deposited is controlled in the Map Sweep setup (Parameters menu).

Unlike a site-based test, an $T_{ox}$ map measurement does not perform a band-bending correction. Although this improves throughput, it might result in a noticeable offset between site and map-based oxide measurements for oxide thicknesses under 100 Å.

## Test Parameters

Figure 3-44 shows the Oxide Thickness Map tab.  Test Limits (Angstroms) are the only parameters to be set (see Table 3-5 ).



Tox Calculations

○ Correct for silicon capacitance: measure Vfb

○ Correct for silicon capacitance:  Assume Vfb (volts) = -0.5

● No correction

Test Limits (Angstroms)

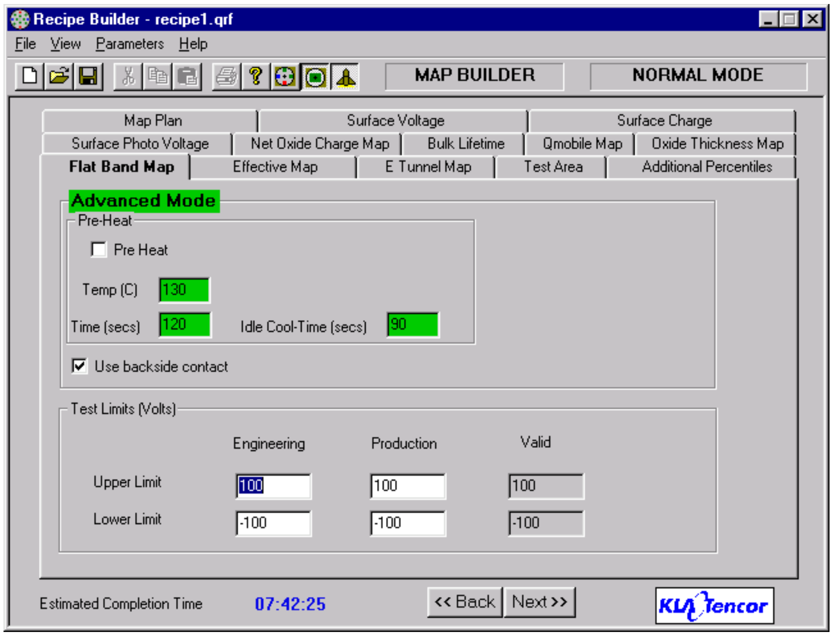
| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 5000 | 5000 | 5000 |
| Lower Limit | 10 | 10 | 10 |

Estimated Completion Time 00:17:56

**Figure 3-44**: Oxide Thickness, Map Test

# Flat Band Voltage Map

Flat Band Voltage map measurements are similar to Flat Band Voltage site-based measurements (page 3-50). Figure 3-45 shows the Flat Band Map tab. Table 3-26 describes the test parameters.



Advanced Mode

Pre-Heat

☐ Pre Heat

Temp (C) 130

Time (secs) 120

Idle Cool-Time (secs) 90

☑ Use backside contact

Test Limits (Volts)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 100 | 100 | 100 |
| Lower Limit | -100 | -100 | -100 |

Estimated Completion Time 07:42:25

**Figure 3-45**: Flatband Voltage Setup, Map Test

**Table 3-26**: Flatband Voltage Parameters

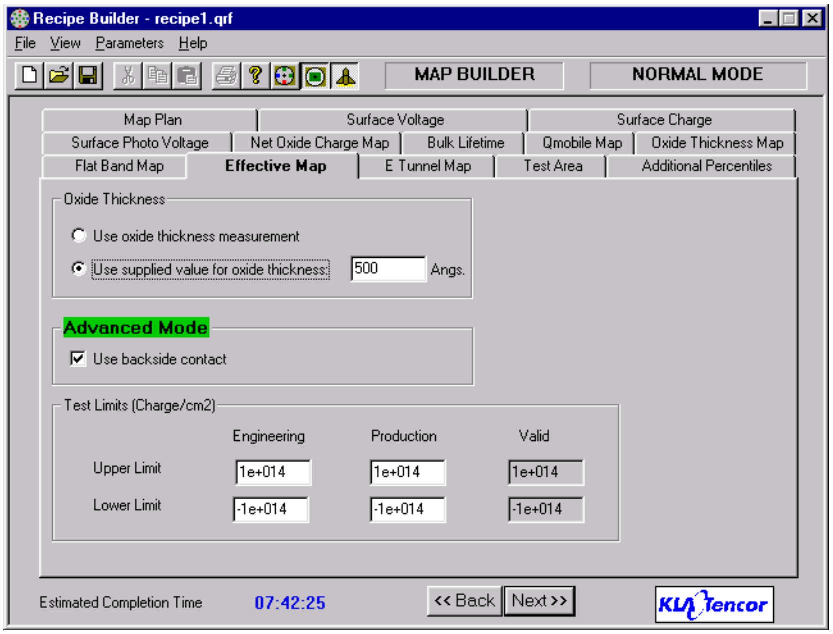
| Parameter | Options | Description |
|---|---|---|
| PreHeat<br>(Advanced Mode) | Temp (C) between 20 and 400<br>Time (secs) between 0 and 600<br>Forced Cool Time (secs) (available for 200-mm systems only). Range: 0 to 300<br>Idle Cool-Time (secs) between 0 and 600 | Instructs the system to pre-heat the wafer at the indicated temperature, for the indicated time. This option will reduce the ~0.3 V offset in $V_{fb}$ due to airborne molecular contamination.<br>The wafer is subsequently cooled by allowing the wafer to sit idle in the chamber for the indicated idle time. |

**Table 3-26**: Flatband Voltage Parameters (Continued)

| Parameter | Options | Description |
|---|---|---|
| Use backside contact<br>(Advanced Mode) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact will be greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-entered (volts) | See Table 3-5. |

# Effective Charge Map ($Q_{eff}$)

Effective Charge map measurements are similar to Effective Charge site-based measurements (page 3-39). Figure 3-18 shows the $Q_{eff}$ Map tab. Table 3-8 describes the testing parameters.



Oxide Thickness

○ Use oxide thickness measurement

● Use supplied value for oxide thickness: 500 Angs.

Advanced Mode

☑ Use backside contact

Test Limits (Charge/cm2)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 1e+014 | 1e+014 | 1e+014 |
| Lower Limit | -1e+014 | -1e+014 | -1e+014 |

Estimated Completion Time 07:42:25

**Figure 3-46**: Effective Charge Setup, Map Test

**Table 3-27**: Effective Charge Parameters

| Parameter | Options | Description |
|---|---|---|
| Oxide Thickness | Use oxide thickness measurement. | The system measures the oxide and use the value in calculating $Q_{eff}$ |
| | User-supplied value for oxide thickness. | The system uses the value entered in the oxide thickness field. An incorrect value will produce inaccurate results.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location will change the value in all.<br>Because oxide thickness and $Q_{eff}$ can be calculated from the same Q-V-SPV data, supplying the oxide thickness will not improve measurement speed. |
| Use backside contact<br>(Advanced Mode) | checked or not checked | Checking employs the backside contact to provide a known reference.<br>Backside contact employs a small needle to penetrate the oxide layer on the back of the wafer. If backside contact is used on wafers with a backside oxide layer thicker than 100 nm, the life of the contact will be greatly reduced. In such a case the oxide layer should be stripped off the back of the wafer in the area of the backside contact. |
| Test Limits | user-defined (Charge/cm$^2$) | See Table 3-5 |

# Tunneling Field Map ($E_{tunnel}$)

$E_{tunnel}$ Map measurements are similar to site-based measurements, however the map test is based on either the user-specified oxide thickness or the results of the Oxide Thickneess Map test.

---

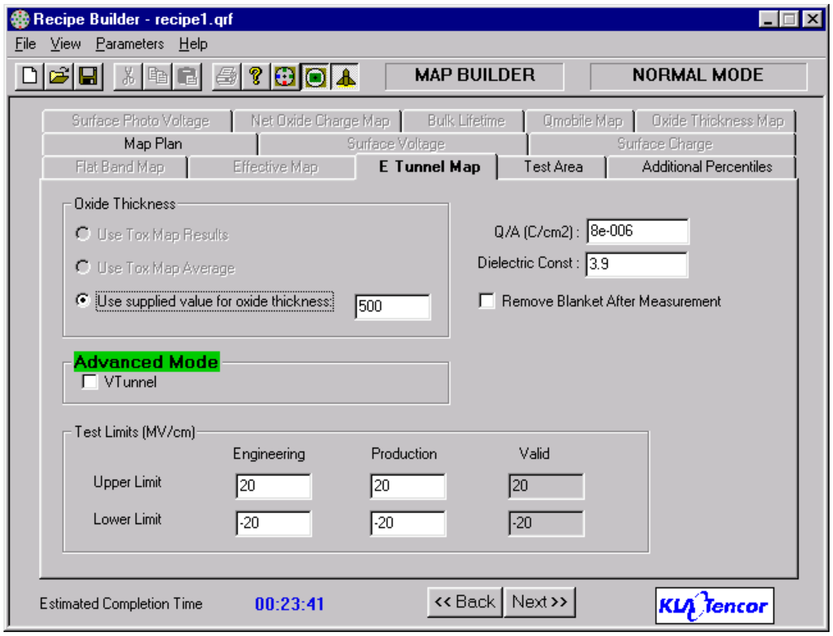
**CAUTION**

The $E_{tunnel}$ Map test should not be performed on wafers with oxides or dielectric thicker than 700 Å. This is because Quantox Kelvin probes can only support up to ±100 V. No machine damage will occur, but the test results will be incorrect. This limitation is also true for the $E_{tunnel}$ site-based measurement.

---

## Test Parameters

Figure 3-47 shows the E Tunnel Map tab. Table 3-28 describes the test parameters.



Oxide Thickness
○ Use Tox Map Results
○ Use Tox Map Average
● Use supplied value for oxide thickness: 500

Q/A (C/cm2) : 8e-006
Dielectric Const : 3.9
☐ Remove Blanket After Measurement

Advanced Mode
☐ VTunnel

Test Limits (MV/cm)

| | Engineering | Production | Valid |
|---|---|---|---|
| Upper Limit | 20 | 20 | 20 |
| Lower Limit | -20 | -20 | -20 |

Estimated Completion Time 00:23:41

**Figure 3-47**: E Tunnel, Map Test

**Table 3-28**: E Tunnel Parameters

| Parameter | Options | Description |
|---|---|---|
| Oxide Thickness | Use $T_{ox}$ Map Results | The system uses $T_{ox}$ Map results to determine the Tunneling Field measurement. |
| | Use $T_{ox}$ Map Average | The system uses the average thickness value from the $T_{ox}$ Map results to determine the Tunneling Field measurement. |
| | Use supplied value for oxide thickness (15 to 10,000Å). | The system uses the value entered in the oxide thickness field.<br>If Tunneling Field is the only test selected, supplying the oxide thickness can significantly reduce measurement time.<br>The oxide thickness field is common to several test tabs and the Wafer Description. Changing the value in one location will change the value in all. |
| Q/A (C/cm2) | user-defined<br>Default value is +8.0 E-6 Coulomb/cm$^2$ for a P-type wafer. | The charge per unit area that will be used in measuring the tunneling field. |
| Dielectric Const | user-defined | Dielectric constant of the silicon |
| Remove Blanket After Measurement | checked or not checked | Removes the charges used for tunneling field measurement. This option is necessary for repeatablility tests.<br>Measurement time can be reduced by deselecting this option. |
| V Tunnel<br>(Advanced Mode) | checked or not checked | |
| Test Limits | user-defined (MV/cm) | See Table 3-5. |

# Chapter 4

# Quantox Operator Interface

The Quantox Operator Interface program (QOI) is used to select the test environment and to control the test process. The Operator Interface program minimizes the number of operator-initiated test variables and provides the appropriate prompts for each of the actions that the operator needs to perform to initiate a test. Once the operator initiates the test, all testing occurs automatically under the control of the computer.

A separate utility, the Quantox Operator Interface Automator (QOI Automator) provides for the creation and execution of script files. Script files enable the system to run a series of recipes automatically thus further reducing the need for operator input.

This chapter describes

# Starting the Operator Interface

Before starting the Operator Interface program (QOI), make sure that the tool is initialized by running the Quantox Startup program (see "Running the Quantox Startup Program" on page 2-9). Wait for Quantox Startup to complete tool initialization before proceeding. Once Quantox Startup finishes, QOI is up and running.

---

**NOTE**

To start QOI without first running Quantox Startup, click the Windows NT Start menu and select Programs | Quantox | Operator Interface.

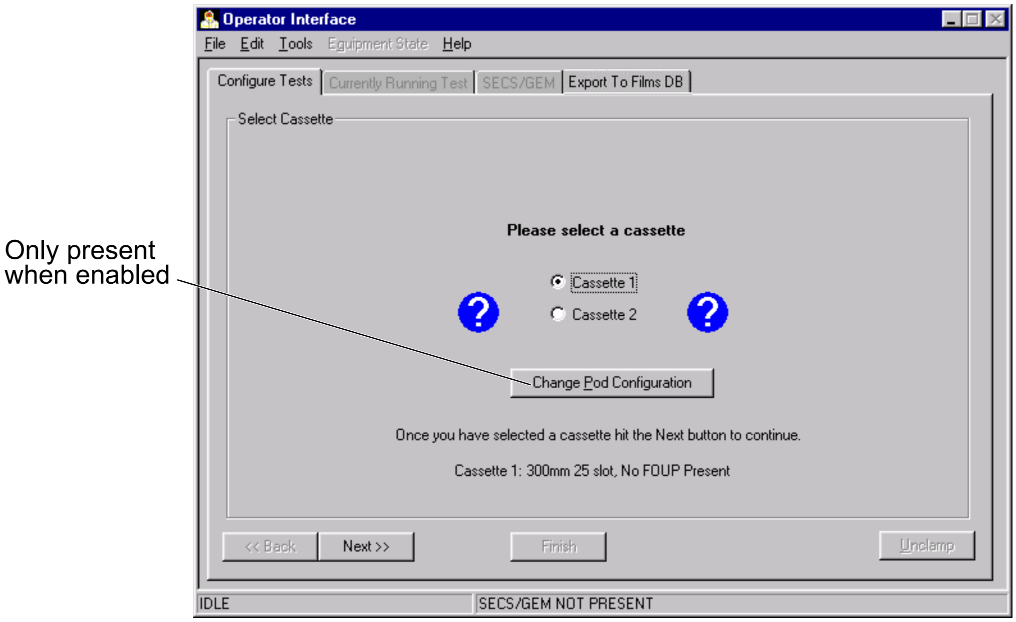
---

When the QOI starts, the Configure Tests tab is opened to the Select Cassette page (Figure 4-1). The Configure Tests tab provides access to the Select Cassette, Select Wafers, Select Recipe, and Configured Test pages. If the system is equipped with the Automation option ***and*** is set to enable modification of the Pod Configuration, the Change Pod Configuration button is available.

To begin testing, place the cassette of wafers on the system's cassette nest, and proceed to the next section.

To manually install a wafer cassette:

6. Set the adjustment brackets on the top of the cassette nest to the size of the wafer to be tested and secure the brackets in place. (Sensors below the cassette nest report the size of the wafer to the system.)
7. After securing the brackets, slide the wafer cassette down onto the cassette nest and ensure that the cassette is situated securely in position.



**Please select a cassette**

● Cassette 1
○ Cassette 2

Once you have selected a cassette hit the Next button to continue.

Cassette 1: 300mm 25 slot, No FOUP Present

IDLE

SECS/GEM NOT PRESENT

**Figure 4-1**: Select Cassette Page

# Selecting a Cassette

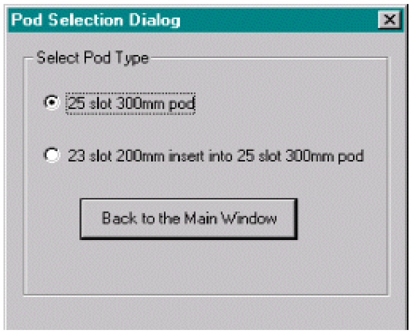
After placing the wafer cassette on the cassette nest, select the cassette from within QOI:

1. Confirm the cassette location, and click the appropriate radio button in the Select Cassette page.

   Cassette 1 is the cassette on the nest closest to the tester. (Only systems equipped with two cassette nests offer a Cassette 2.)

2. If the Pod configuration needs to be changed (automated systems only) and the configuration option is enabled, click the Pod Configuration button. Otherwise, go to step 4.

   The Pod Selection Dialog box opens. Figure 4-2 shows the box for 300-mm systems.



Pod Selection Dialog

Select Pod Type

● 25 slot 300mm pod

○ 23 slot 200mm insert into 25 slot 300mm pod

**Figure 4-2**: Pod Selection Dialog Box, 300-mm systems

3. Select the appropriate Pod (or Pod and insert) type, and click the Back to Main Window button.

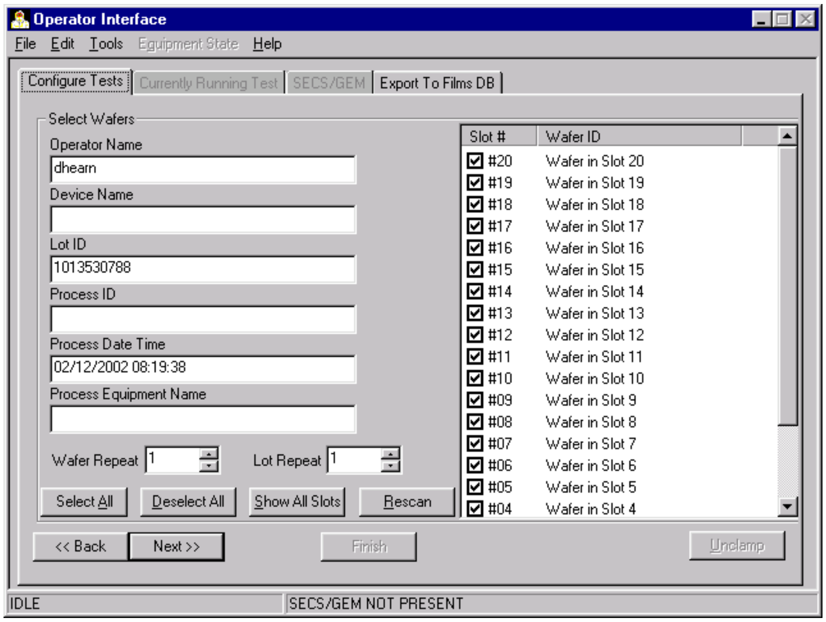
4. Click the Next button to continue.

   The Quantox system checks for a cassette on the selected cassette nest:

   - If the system does not detect a cassette, it prompts the operator to place a cassette on the nest.
   - If the system detects a cassette, the program asks for confirmation of the selection. After receiving confirmation, the program displays the Select Wafers page (Figure 4-3).

# Selecting Wafers

After the cassette selection is confirmed, the robotic arm uses a laser to scan the cassette for wafers, and the Select Wafers page is displayed (Figure 4-3). The right-hand side of the page identifies the slots where wafers were found. The left-hand side of the page displays a series of fields that enable the operator to input data relevant to the test process and test wafers.



Operator Name: dhearn
Device Name:
Lot ID: 1013530788
Process ID:
Process Date Time: 02/12/2002 08:19:38
Process Equipment Name:
Wafer Repeat: 1
Lot Repeat: 1

| Slot # | Wafer ID |
|---|---|
| ☑ #20 | Wafer in Slot 20 |
| ☑ #19 | Wafer in Slot 19 |
| ☑ #18 | Wafer in Slot 18 |
| ☑ #17 | Wafer in Slot 17 |
| ☑ #16 | Wafer in Slot 16 |
| ☑ #15 | Wafer in Slot 15 |
| ☑ #14 | Wafer in Slot 14 |
| ☑ #13 | Wafer in Slot 13 |
| ☑ #12 | Wafer in Slot 12 |
| ☑ #11 | Wafer in Slot 11 |
| ☑ #10 | Wafer in Slot 10 |
| ☑ #09 | Wafer in Slot 9 |
| ☑ #08 | Wafer in Slot 8 |
| ☑ #07 | Wafer in Slot 7 |
| ☑ #06 | Wafer in Slot 6 |
| ☑ #05 | Wafer in Slot 5 |
| ☑ #04 | Wafer in Slot 4 |

**Figure 4-3**: Select Wafers Page

To edit the Select Wafers page:

1. Review the current entries (refer to the descriptions in Table 4-1).
2. Enter a new Operator Name, Device Name, Lot ID and Process information as required.
3. Edit the Wafer and Lot Repeat selections using the associated scroll indicators.
4. Edit the Wafer selection using the buttons and checkboxes described in Table 4-1.
5. If a Wafer ID needs to be edited, double-click the ID to display the Edit Wafer IDs dialog box (Figure 4-4).
   - Note: It is sometimes necessary to double-click ***slowly*** for this step to work.

Slot #16

Wafer in slot 16

**Figure 4-4**: Edit Wafer IDs Dialog Box

The text above the Wafer ID field identifies the slot number of the selected wafer.

- To change the ID, replace the text in the Wafer ID field.
- To step through the list of Wafer IDs and make additional changes, click the Prev ID or Next ID button.

---

**NOTE**

Operator Interface fields accept any legal alphanumeric characters. Do not use `: * [ ] | ( ) ? ! - + or #`

---

6. When finished editing the Wafer IDs:
   - Click OK to confirm all changes.
   - Click Cancel to discard all changes.

   The display returns to the Select Wafers page.

7. When entries are completed, click the Next button to proceed to the Select Recipe page (Figure 4-5).

**Table 4-1**: Fields and Buttons in the Select Wafers Page

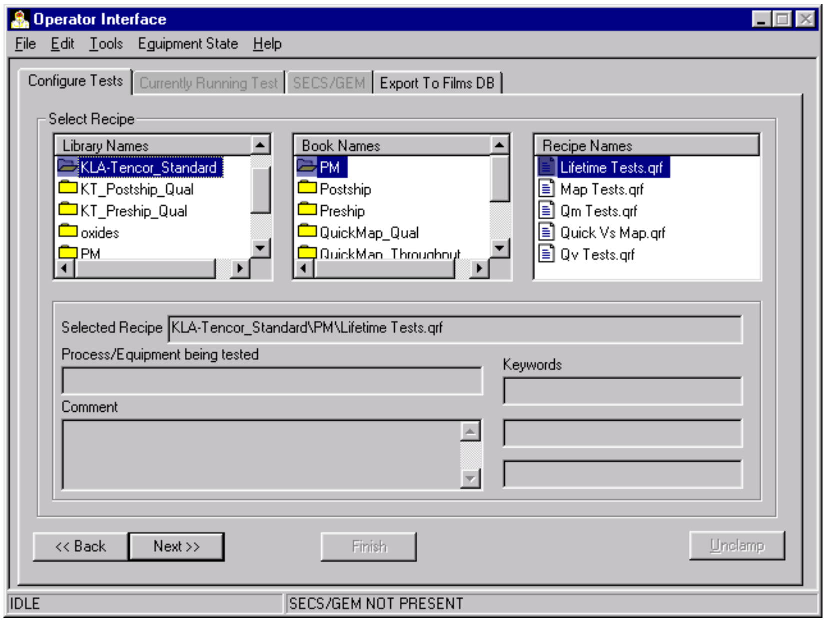
| Field or Button | Description |
|---|---|
| Operator Name,<br>Device Name,<br>Lot ID,<br>Process ID,<br>Process Date Time (MM/DD/YYYY),<br>Process Equipment | By default, the Operator Name field displays the name entered in the Windows NT logon. Fields can be edited by keying in new entries.<br>The fields Process Date Time and Process Equipment are only available when the Klarity option is enabled. (These are required entries for the Klarity option.)<br>Field headings can be edited (see page 4-18). |
| Wafer Repeat | The number of times each selected wafer is tested before the next wafer in the lot is tested. For example, if wafer slots 1 and 2 are selected and the Wafer Repeat is 2, testing would proceed as follows:<br>slot 1, slot 1<br>slot 2, slot 2<br>The wafer remains on the chuck between each repeat. |
| Lot Repeat | The number of times the lot of selected wafers is tested. For example, if wafer slots 1 and 2 are selected and the Lot Repeat is 2, testing would proceed as follows:<br>slot 1<br>slot 2<br>slot 1<br>slot 2<br>The wafer is removed from the chuck between each repeat. |
|  | If both Wafer and Lot Repeats are set to 2, testing would proceed as follows<br>slot 1, slot 1<br>slot 2, slot 2<br>slot 1, slot 1<br>slot 2, slot 2 |
| Rescan | Directs the robotic arm to rescan the cassette for wafers. Rescan is useful if the original cassette is removed and replaced with another cassette. When the rescan is completed, the wafer list displays the results of the rescan. |
| Select All | Selects all wafers |
| Deselect All | Deselects all wafers |

**Table 4-1**: Fields and Buttons in the Select Wafers Page (Continued)

| Field or Button | Description |
|---|---|
| Show All Slots | Lists all slots in the cassette whether or not they contain wafers |
| Slot # | Slot # (number) identifies the slots in the current cassette. Slots are numbered from the bottom of the cassette to the top in ascending order. By default, only slots containing wafers are listed. To show all slots, click the Show All Slots button to the left of the list.<br>A check mark in the Slot # box indicates that the wafer is tested. By default, all wafers are selected.<br>• To deselect or select a wafer, click the box to the left of the wafer's slot number.<br>• To deselect all wafers, click Deselect All. |
| Wafer ID | Identifies the wafer. The default Wafer ID is derived from the wafer's slot location. To edit a wafer's ID, double-click the ID and entering a new ID in the Wafer ID dialog box. The ID should consist of no more that 30 valid alphanumeric characters. |
| Back | Displays the previous page |
| Next | Displays the next page |

# Selecting a Recipe

The Select Recipe page (Figure 4-5) allows you to select the test *recipe* used. To get to this page, click Next at the bottom of the Select Wafers page. (Recipes are created by the test engineer using the Recipe Builder program. After creating a recipe, the engineer saves the recipe in a *book* of related recipes. The book is stored in a *library* of related books.)



Selected Recipe: KLA-Tencor_Standard\PM\Lifetime Tests.qrf

IDLE | SECS/GEM NOT PRESENT

**Figure 4-5**: Select Recipe Page

To select a recipe:

1. In the Library Names list, select the desired library by clicking it.
2. In the Book Names list, select the desired book.
3. In the Recipe Names list, select the desired recipe.

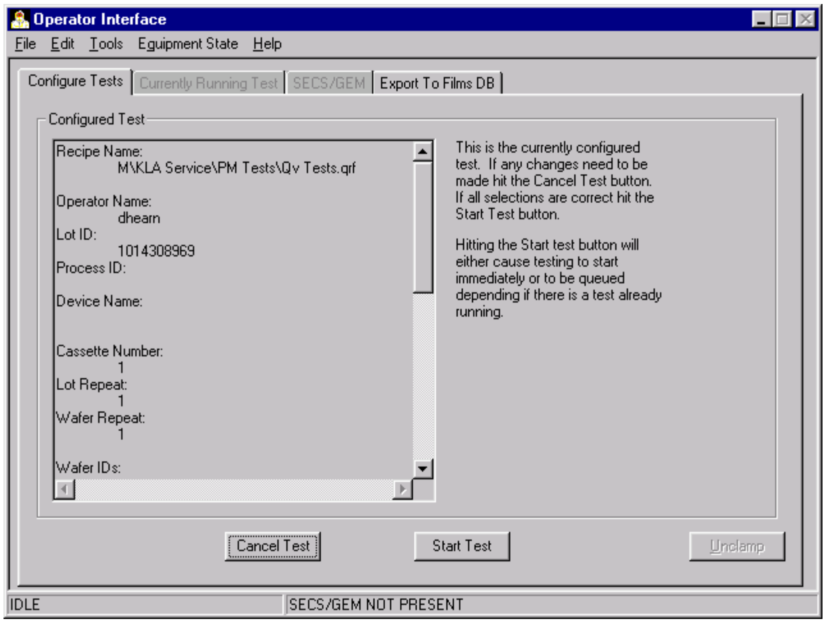
   The bottom half of the page displays the path of the selected recipe as well as process information, comments, and keywords entered into the recipe file by the test engineer. The comments and keywords are used to help identify the selected recipe.
4. When the selection is complete, click the Next button to proceed to the Configured Test page (Figure 4-6).

# Starting a Test

The Configured Test page (Figure 4-6) shows a summary of the currently configured test. The page displays the recipe, operator name, lot and process IDs, and other data related to the test. The Configured Test page gives the operator an opportunity to review the test configuration before beginning the test.

- To cancel the test, click the Cancel Test button. A dialog box asks for confirmation:
    - To return to the Configured Test page click No.
    - To confirm the cancellation, click Yes. The display returns to the Select Cassette page.
- To start the test, click the Start Test button. The screen displays the Currently Running Test tab (Figure 4-7).

When testing is complete, the operator can configure another test or log off the system.



Recipe Name:
M\KLA Service\PM Tests\Qv Tests.qrf

Operator Name:
dhearn
Lot ID:
1014308969
Process ID:

Device Name:

Cassette Number:
1
Lot Repeat:
1
Wafer Repeat:
1

Wafer IDs:

This is the currently configured test. If any changes need to be made hit the Cancel Test button. If all selections are correct hit the Start Test button.

Hitting the Start test button will either cause testing to start immediately or to be queued depending if there is a test already running.

IDLE

SECS/GEM NOT PRESENT

**Figure 4-6**: Configured Test Page

# Monitoring the Test

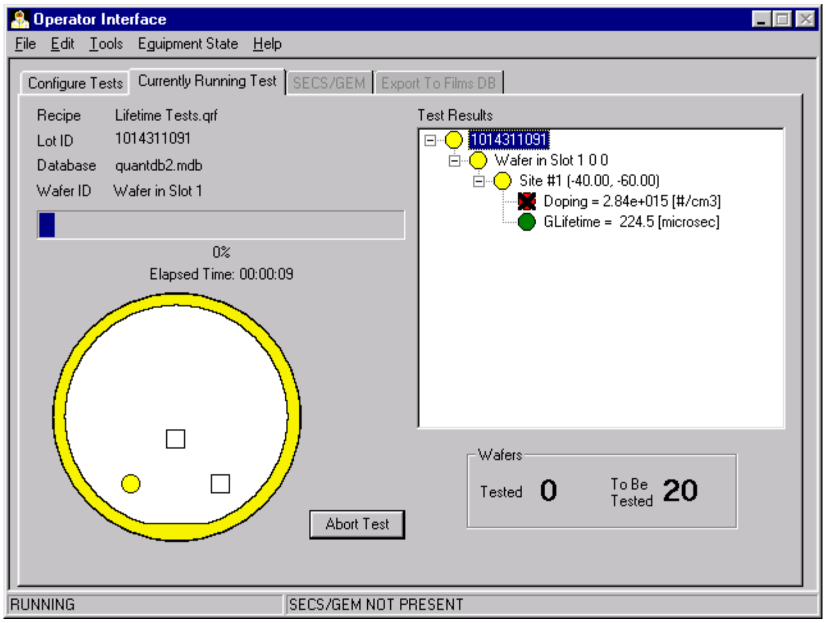
The Currently Running Test tab (Figure 4-7) reports the test status and results as the test proceeds, enabling the operator to monitor the test in progress. If needed, click the Abort Test button to stop the test.

---

**NOTE**

The Abort response is not always immediate. The system might continue testing for a few minutes after the Abort button is clicked.

---



Recipe Lifetime Tests.qrf
Lot ID 1014311091
Database quantdb2.mdb
Wafer ID Wafer in Slot 1

0%
Elapsed Time: 00:00:09

1014311091
Wafer in Slot 1 0 0
Site #1 (-40.00, -60.00)
Doping = 2.84e+015 [#/cm3]
GLifetime = 224.5 [microsec]

Tested 0
To Be Tested 20

RUNNING
SECS/GEM NOT PRESENT

**Figure 4-7**: Currently Running Test Tab (site-based test)

The Currently Running Test tab displays

- The Recipe, Lot ID, and Wafer ID being processed as well as the target Database (if data is being exported).
- A progress bar which reports the percent of the test that is complete (based on the number of sites being tested).
- The Elapsed Time since the test began (hours:minutes:seconds).

- The Test Results report displays results from ***all tests run*** since the Operator Interface started. Shutting down the Operator Interface clears the results from prior tests.

  Test results are displayed in a hierarchical manner, starting with the Lot ID:

  - Clicking the Lot ID expands the display to show the wafer IDs of the wafers that have been run.
  - Clicking a wafer expands the display to show a list of all the sites and maps that have been tested on that wafer.
  - Clicking a site expands the display to show all the tests and results for the site.
  - Clicking a map expands the display to show all the map tests that were run and the average of all points tested on the wafer.

  The wafer icons show the status of the tests. The worst status is propagated up to the lot level. If one test fails, the red icon is shown on all levels starting from where the test failed. For example, if $T_{ox}$ passed on a site but $Q_m$ failed, the red icon is shown on the site, wafer, and lot branches.

- The Wafers report shows how many wafers have been tested and how many wafers remain to be tested.
- A wafer image further describes the test progress and state. The test type determines the display on the image:

  - For a site-based test, a symbol describes the site-by-site test results (a legend in the Tools menu explains the symbols).
  - For a simple map-based test (VS, SPV, $Q_{surf}$, $Q_{net}$), the mapping progress is shown.

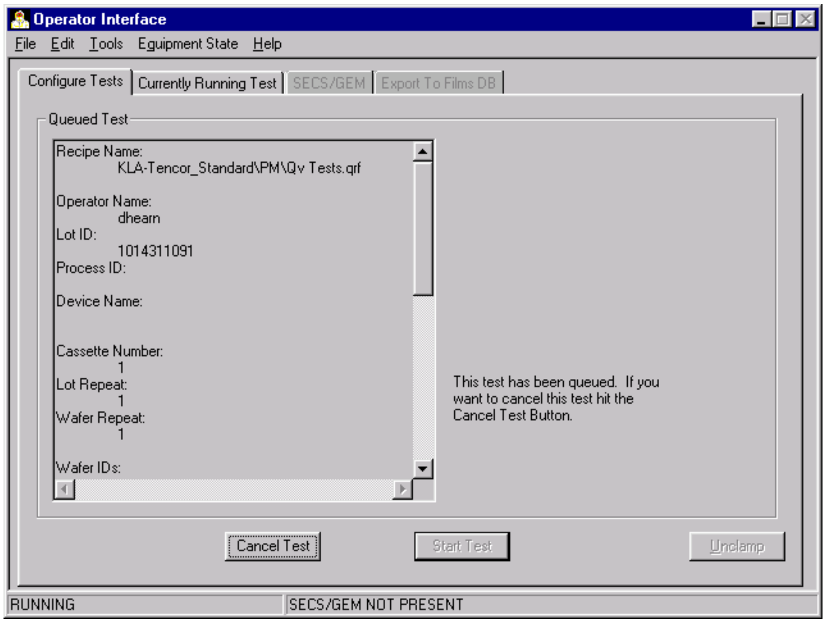
  A ring around the wafer image changes color as the test state changes. Table 4-2 describes the different test states and the associated ring color.

**Table 4-2**: Test State Descriptions

| State | Description | Ring Color |
|---|---|---|
| Idle | Testing has not started. | Yellow or status of last test |
| Loading | A wafer is being loaded. | Yellow |
| Running | A wafer is being tested. | Yellow |
| Mapping | A wafer is being mapped. | Yellow |
| Pass | The wafer has passed production limits. | Green |
| Fail | The wafer has failed production limits. | Red |
| Error | An error has occurred. | Red |

# Configuring a Second Cassette

After starting a test on one cassette, you can configure a test for the second cassette (on systems equipped with two cassette nests). You can begin configuring the second cassette at any time after the first test is started by clicking the Configure Tests tab. All setup steps are the same, however when you click the Start Test button for the second test, the second test is put into a test queue, as shown in Figure 4-8. The second test begins immediately after the first tests ends. The first cassette can then be configured for a subsequent test.



Recipe Name:
KLA-Tencor_Standard\PM\Qv Tests.qrf

Operator Name:
dhearn
Lot ID:
1014311091
Process ID:

Device Name:

Cassette Number:
1
Lot Repeat:
1
Wafer Repeat:
1

Wafer IDs:

This test has been queued. If you want to cancel this test hit the Cancel Test Button.

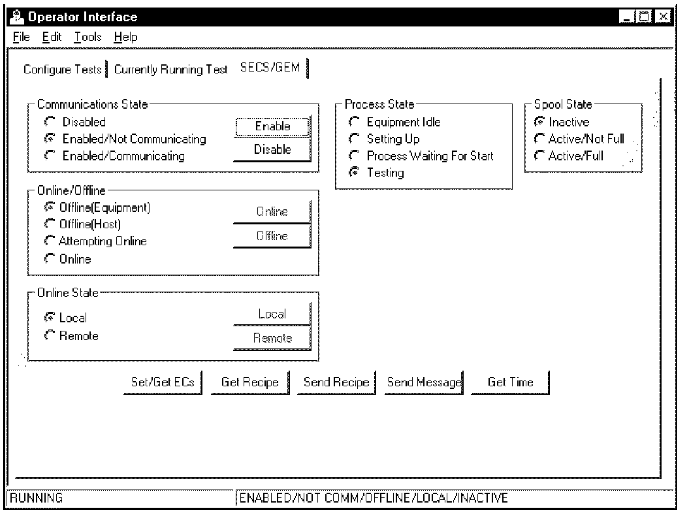
RUNNING

SECS/GEM NOT PRESENT

**Figure 4-8**: Queued Test Page

# Using the SECS/GEM Operator Interface

If the SECS/GEM Interface is installed, the SECS/GEM tab is active (Figure 4-9). Table 4-3 briefly describes the function of the tab. Refer to the SECS/GEM manual for the current software version for additional information.



Communications State
○ Disabled
● Enabled/Not Communicating
○ Enabled/Communicating

Process State
○ Equipment Idle
○ Setting Up
○ Process Waiting For Start
● Testing

Spool State
● Inactive
○ Active/Not Full
○ Active/Full

Online/Offline
● Offline(Equipment)
○ Offline(Host)
○ Attempting Online
○ Online

Online State
● Local
○ Remote

RUNNING | ENABLED/NOT COMM/OFFLINE/LOCAL/INACTIVE

**Figure 4-9**: SECS/GEM Interface Window

**Table 4-3**: Function of the SECS/GEM Interface Window

| State | Option/Button | Description |
|---|---|---|
| Communication State | Enabled<br>Disabled | Reports the current SECS-II communications state of the Quantox system.<br>The operator can enable or disable communications by clicking the associated button. |
| Online/Offline | Online<br>Offline | When communications is enabled, reports the system's current control state.<br>The operator can bring the Quantox online or offline by clicking the associated button. |

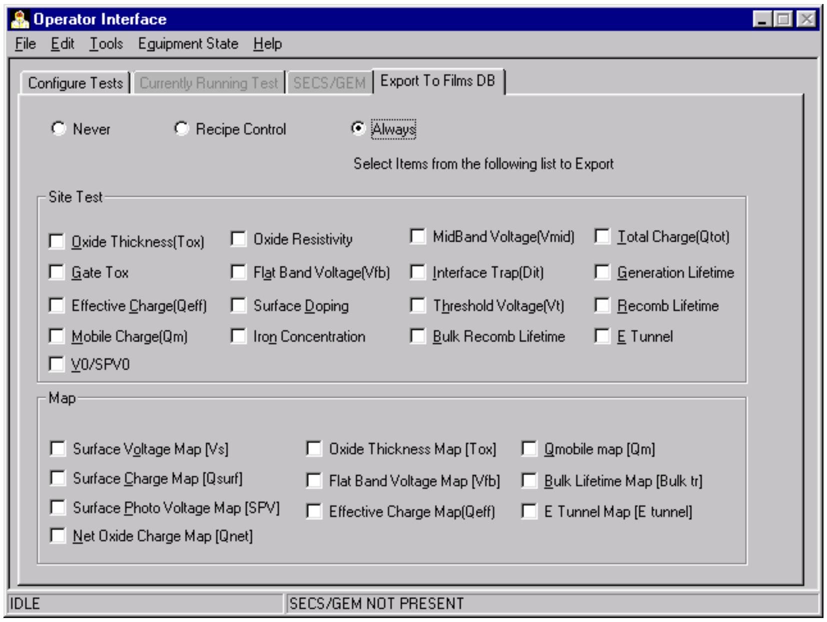
**Table 4-3**: Function of the SECS/GEM Interface Window (Continued)

| State | Option/Button | Description |
|---|---|---|
| Online State | Local<br>Remote | When the system is online, reports whether the system is under local control (operator) or remote control (host).<br>The operator can bring the system to local or remote control by clicking the associated button. |
| Process State | Equipment Idle<br>Setting Up<br>Process Waiting For Start<br>Testing | Displays the current process state |
| Spool State | Inactive<br>Active/Not Full<br>Active/Full | Displays the current spooling state |
| — | Set/Get ECs | Enables the operator to set or query the value of a GEM equipment constant |
| — | Get Recipe | Enables the operator to download a recipe from the host |
| — | Send Recipe | Enables the operator to upload a recipe to the host |
| — | Send Message | Enables the operator to send a text message to the host |
| — | Get Time | Enables the operator to synchronize the Quantox SECS/GEM interface time-base to the host |

# Export to Films Database

If the Klarity option is enabled, the Export to Films DB tab is active (Figure 4-10). This page enables the operator to define when data is exported to the Common Database, prior to running the test. (The tab is disabled during testing.)

If the Always option is selected, Site Test and Map selections are enabled, as shown in Figure 4-10. Refer to Table 4-4 for details.



○ Never ○ Recipe Control ● Always

Select Items from the following list to Export

Site Test

| | | | |
|---|---|---|---|
| ☐ Oxide Thickness(Tox) | ☐ Oxide Resistivity | ☐ MidBand Voltage(Vmid) | ☐ Total Charge(Qtot) |
| ☐ Gate Tox | ☐ Flat Band Voltage(Vfb) | ☐ Interface Trap(Dit) | ☐ Generation Lifetime |
| ☐ Effective Charge(Qeff) | ☐ Surface Doping | ☐ Threshold Voltage(Vt) | ☐ Recomb Lifetime |
| ☐ Mobile Charge(Qm) | ☐ Iron Concentration | ☐ Bulk Recomb Lifetime | ☐ E Tunnel |
| ☐ V0/SPV0 | | | |

Map

| | | |
|---|---|---|
| ☐ Surface Voltage Map [Vs] | ☐ Oxide Thickness Map [Tox] | ☐ Qmobile map [Qm] |
| ☐ Surface Charge Map [Qsurf] | ☐ Flat Band Voltage Map [Vfb] | ☐ Bulk Lifetime Map [Bulk tr] |
| ☐ Surface Photo Voltage Map [SPV] | ☐ Effective Charge Map(Qeff) | ☐ E Tunnel Map [E tunnel] |
| ☐ Net Oxide Charge Map [Qnet] | | |

IDLE

SECS/GEM NOT PRESENT

**Figure 4-10**: Export to Films DB Page

**Table 4-4**: Options for Exporting to the Films DB

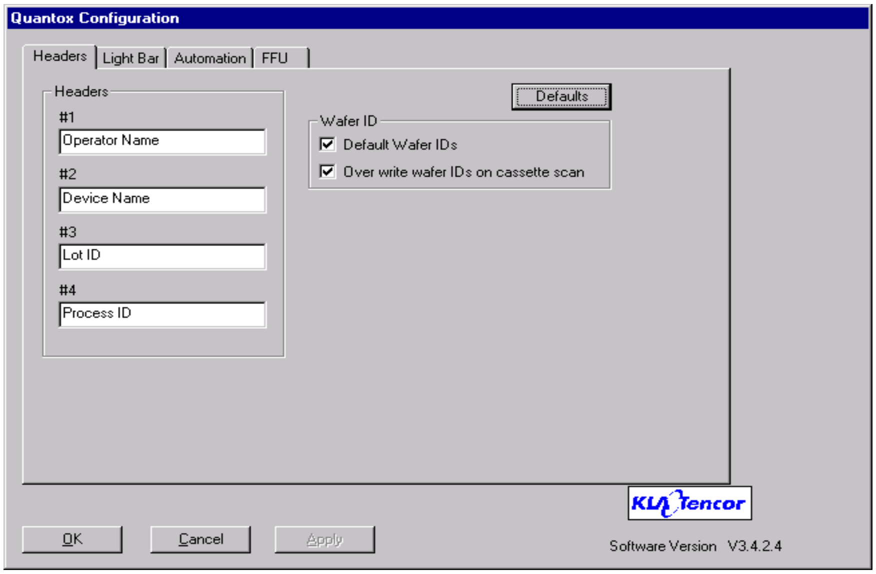
| Option | Description |
|---|---|
| Never | Data shall not be exported to the Common Database regardless of the setting in the Recipe Builder's Site and Map Plans. |
| Recipe Control | The data shall be exported if the Export to Films Database option is selected in the Recipe Builder. |
| Always | Selected Data shall always be exported.<br>Selecting the Always option enables the check boxes in the Site Test and Map regions of the page. Checking a test directs the software to always export the test's data to the Common Database. |

# Editing the Configuration Options

The QOI configuration options are accessed from the Tools | Options menu. The Options selection displays the Quantox Configuration dialog box (Figure 4-11). The Configuration dialog box comprises the following tabs:

- Headers: for configuring the headers displayed in the Operator Interface and included in Quantox reports.
- Light Bar: for configuring system status lights and buzzers (on systems equipped with a light bar)
- Automation: for configuring the Operator Interface for automation.
- FFU: for configuring the system response to a Fan Filter Unit (FFU) alarm.

These configuration options are modified on a system-to-system basis. All systems must be configured separately.



Headers
#1 Operator Name
#2 Device Name
#3 Lot ID
#4 Process ID

Wafer ID
☑ Default Wafer IDs
☑ Over write wafer IDs on cassette scan

Software Version V3.4.2.4

**Figure 4-11**: Quantox Configuration, Headers

## Headers

The Fields in the Headers tab (Figure 4-11) enable the operator to edit the headers displayed in the Operator Interface (Select Wafers and Configured Test pages) and included in Quantox test reports from the Report Generator. Titles can be up to 32 characters long. Default titles are

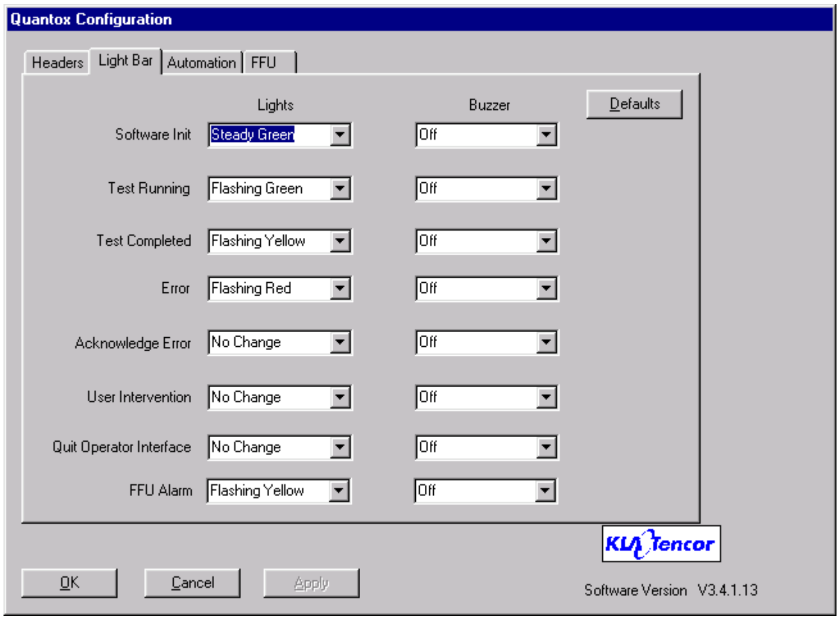
- Operator Name
- Device Name
- Lot ID
- Process ID

Two checkboxes control the Wafer ID display:

- Checking the Default Wafer ID box directs the software to enter default values (“Wafer in Slot *x*”) in the Wafer ID fields of the Operator Interface. (These default values can be edited in the Select Wafers page.)
- Checking the Over write wafer IDs on cassette scan box directs the software to overwrite existing wafer IDs with the default values if a cassette is rescanned. (These default values can be edited in the Select Wafers page.)

## Light Bar

Fields in the Light Bar tab enable the operator to modify the behavior of the light (status) bar in response to system events. Current settings are modified using the drop-down menus in the Lights and Buzzer columns. Options vary depending on the associated event. Figure 4-12 shows the default settings. Table 4-5 lists the optional settings.



| | Lights | Buzzer |
|---|---|---|
| Software Init | Steady Green | Off |
| Test Running | Flashing Green | Off |
| Test Completed | Flashing Yellow | Off |
| Error | Flashing Red | Off |
| Acknowledge Error | No Change | Off |
| User Intervention | No Change | Off |
| Quit Operator Interface | No Change | Off |
| FFU Alarm | Flashing Yellow | Off |

**Figure 4-12**: Quantox Configuration, Light Bar

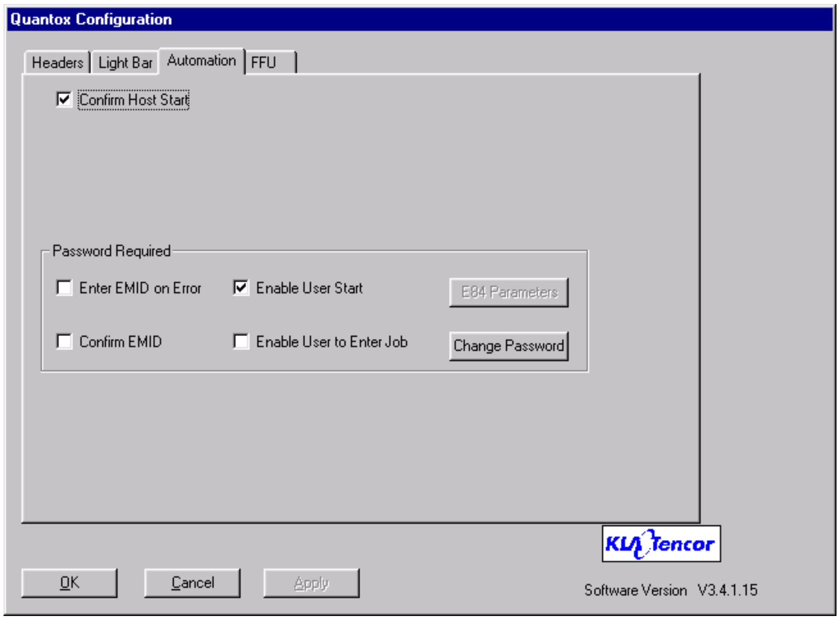
**Table 4-5**: Status Signal Options for Light Bar

| **Light Options (default indication)** | **Buzzer Options[a] (default indication)** |
|---|---|
| Steady Green (default for Software Init) | On |
| Flashing Green (default for Test Running) | Off (default for all) |
| Steady Yellow | Flashing |
| Flashing Yellow (default for Test Completed) | No Change |
| Steady Red | |
| Flashing Red (default for Error) | |
| Steady Blue | |
| Flashing Blue | |
| Steady White | |
| Flashing White | |
| No Change (default for Acknowledge Error, User Intervention, and Quit Operator Interface) | |

[a] Buzzer operations are only supported on 300-mm systems equipped with the buzzer option.

## Automation

Check boxes in the Automation tab (Figure 4-13) enable operators to modify the interaction with the Host computer. The settings grouped under Password Required are password-protected.



☑ Confirm Host Start

Password Required

☐ Enter EMID on Error

☑ Enable User Start

☐ Confirm EMID

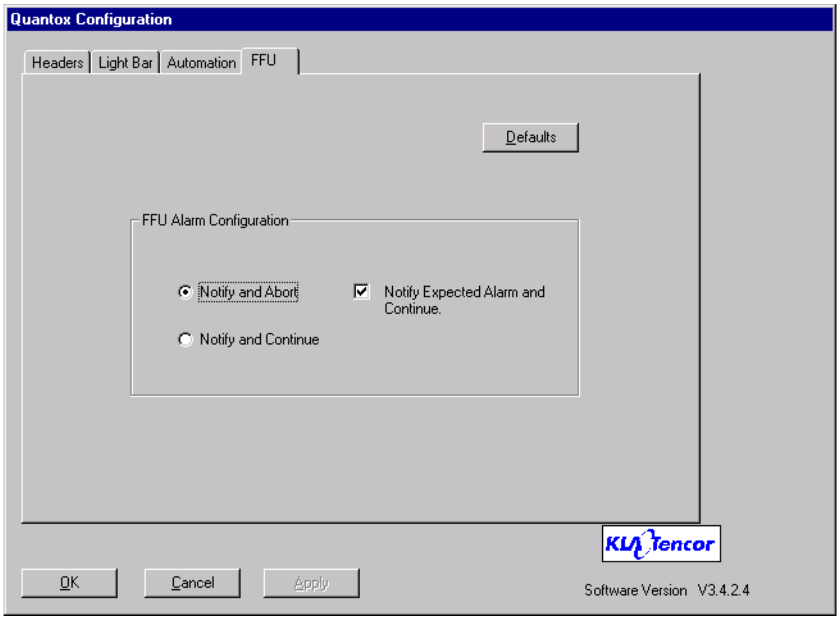
☐ Enable User to Enter Job

Software Version V3.4.1.15

**Figure 4-13**: Quantox Configuration, Automation

## Fan Filter Unit

Check boxes in the Fan Filter Unit (FFU) tab (Figure 4-14) enable the operator to configure the system's response to an FFU alarm. Table 4-6 describes the configuration options.



FFU Alarm Configuration

● Notify and Abort

○ Notify and Continue

☑ Notify Expected Alarm and Continue.

Software Version V3.4.2.4

**Figure 4-14**: Quantox Configuration, FFU

**Table 4-6**: FFU Alarm Responses

| Configuration | Description |
|---|---|
| Notify and Abort | When an FFU alarm occurs, the alarm message is sent to the host (if installed), User Interface, and light tower. If the tool is processing wafers, the tool immediately stops wafer processing and closes all open FOUP doors. All current wafer transport operations are completed as soon as possible. As long as the FFU alarm state is active, no wafer processing is permitted.<br>This is the default selection.<br>If the Notify Expected Alarm and Continue box is checked, the tool sends any Expected Alarm Messages to the host (if installed), and continues normal operation.<br>The Notify Expected Alarm and Continue box is checked by default (when Notify and Abort is selected).<br>Note When Notify and Abort is selected, the system stops completely. The only want to resume operation is to do a Quantox Startup. Thus it is recommended that you choose Notify and Continue. |
| Notify and Continue | When an FFU alarm occurs, all current jobs are executed, and the alarm message is sent to the host (if installed), User Interface, and light tower. |

# Using the Operator Interface Automator

The Quantox® Operator Interface Automator (QOI Automator) is a utility that allows you to create and run script files. A QOI automator script file comprises a set of test recipes and wafer selections that can be run automatically as a single procedure.

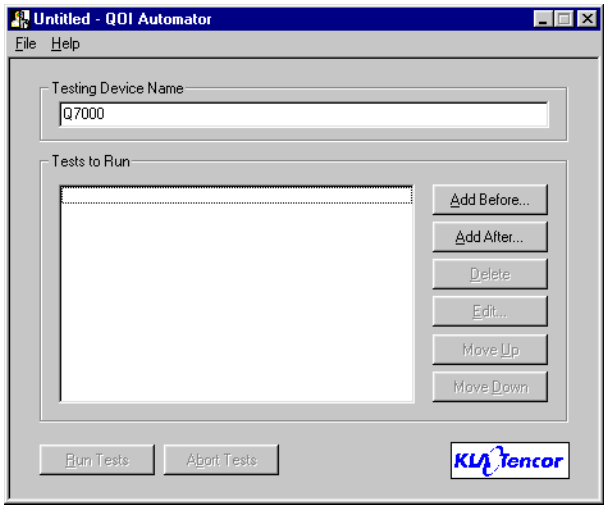
QOI Automator script files (*. qas) are stored in the C:\Quantox\Scripts directory. When a QOI Automator script is run, the QOI Automator simulates the actions of an operator running the individual recipes from the Quantox Operator Interface.

## Creating a QOI Automator Script File

To create a script file:

1. From the Windows NT Start menu, select Programs | Quantox | QOI AUTOMATOR.

   The QOI Automator window opens (Figure 4-15). The designation "Untitled" in the Title bar indicates that this is a new file.



Testing Device Name: Q7000

**Figure 4-15**: QOI Automator Window

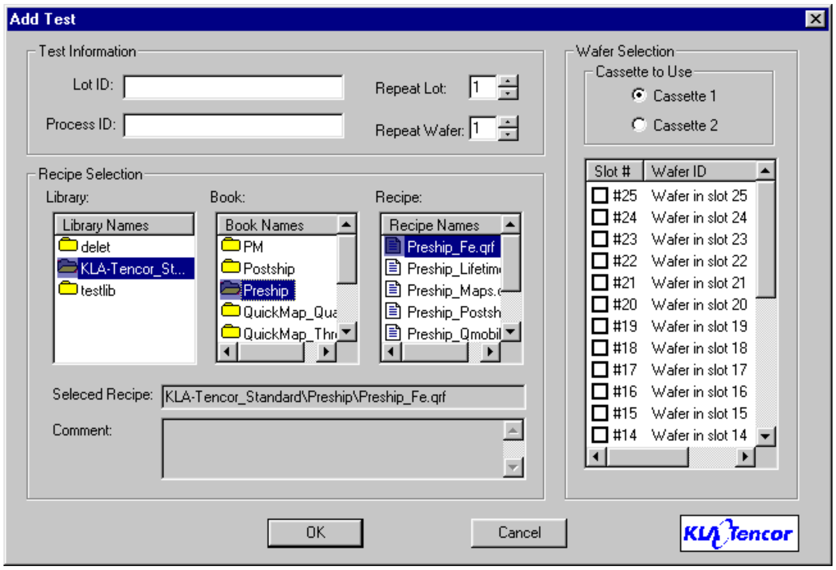
2. If desired, edit the name in the Testing Device Name field.

   The Testing Device Name is included in reports generated by the Quantox Report Generator. By default, the Testing Device Name is the Quantox tool's serial number.

3. The Tests to Run list shows the selected tests in the order in which they will run. Because Figure 4-15 depicts a new file, the Tests to Run list is

empty. To add the first test to the list, click either the Add Before or Add After button.

The Add Test window opens (Figure 4-16). Table 4-7 describes the fields and buttons in the window



Repeat Lot: 1

Repeat Wafer: 1

● Cassette 1

○ Cassette 2

| Slot # | Wafer ID |
|---|---|
| ☐ #25 | Wafer in slot 25 |
| ☐ #24 | Wafer in slot 24 |
| ☐ #23 | Wafer in slot 23 |
| ☐ #22 | Wafer in slot 22 |
| ☐ #21 | Wafer in slot 21 |
| ☐ #20 | Wafer in slot 20 |
| ☐ #19 | Wafer in slot 19 |
| ☐ #18 | Wafer in slot 18 |
| ☐ #17 | Wafer in slot 17 |
| ☐ #16 | Wafer in slot 16 |
| ☐ #15 | Wafer in slot 15 |
| ☐ #14 | Wafer in slot 14 |

Seleced Recipe: KLA-Tencor_Standard\Preship\Preship_Fe.qrf

**Figure 4-16**: Add Test Window

To configure the test:

1. In the Add Test window, enter the Lot and Process IDs.
2. If desired, edit the Repeat Lot or Repeat Wafer entries by clicking the scroll up or scroll down indicator to the right of the entry.
3. Select the desired Library, Book, and Recipe by clicking on the names in their respective lists.

   Check the Comments field for any information entered by the test engineer.
4. In the Wafer Selection area of the window, click to select Cassette 1 or Cassette 2 as appropriate.
5. If the Wafer ID should be edited, double-click the ID to display the Edit Wafer IDs dialog box (Figure 4-17). The text above the Wafer ID field identifies the slot number of the selected wafer.
   - To change the ID, replace the text in the Wafer ID field.
   - To step through the list of Wafer IDs and make additional changes, click the Prev ID or Next ID button.

Slot #16

Wafer in slot 16

**Figure 4-17**: Edit Wafer IDs Dialog Box

6. When finished editing the Wafer IDs:
   - Click OK to confirm all changes.
   - Click Cancel to discard all changes.

   The display returns to the Add Test window.

---

**NOTE**

When a Wafer ID is edited, it is automatically selected.

---

7. To select additional wafers, click the box to the left of the Wafer IDs in the Add Test window.
8. When finished setting up the test:
   - Click OK to confirm the changes. (Clicking OK without selecting at least one wafer will cause the system to display a warning message.)
   - Click Cancel to discard changes.

   The display returns to the QOI Automator window.
9. To add a second test to the Tests To Run list, click the Add Before or Add After button, depending upon where the test should be placed in the sequence. Repeat steps 1 through 8 to set up the test as required.

   When adding subsequent tests, first decide where the test should be placed, click-select an adjacent test, then click the Add Before or Add After button as appropriate. Tests can be resequenced or deleted from the list if necessary (see “Editing a QOI Automator Script File” ).
10. When the script is complete, go to the File menu and select Save.

    The Save As window opens. The default directory is C:\Quantox\Scripts. The default Save as type is Automator Files. The default extension is `.qas`, which stands for QOI Automator Script.
11. Enter a name into the File name: field and click Save.

**Table 4-7**: Fields and Buttons in the Add Test Window

| Field | Options | Description |
|---|---|---|
| Lot ID | user-defined | Used to describe the lot of wafers. This is the name displayed in the Tests to Run list (Figure 4-15). Enter only valid alphanumeric characters. |
| Process ID | user-defined | Used to describe the test process. Typically the tests in a script share a Process ID. Enter only valid alphanumeric characters. |
| Repeat Lot | 1 to 50 | The number of times the lot of wafers runs in sequence. The default is 1, indicating that the lot is run only once.<br>Wafers are removed from the chuck between each repetition of the lot. See Table 4-1 for additional information. |
| Repeat Wafer | 1 to 50 | The number of times each wafer is tested before the next wafer is tested. The default is 1, indicating that the wafers are tested only once per lot run.<br>The wafer remains on the chuck between wafer repetitions. See Table 4-1 for additional information. |
| Library Names | all valid Library names | The highlighted library is the currently selected library. By default, this is the first library in the list. |
| Book Names | all valid Book names | The highlighted book is the currently selected book. By default, this is the first book in the list. |
| Recipe Names | all valid Recipe names | The highlighted recipe is the currently selected recipe. By default this is the first recipe in the list. |
| Selected Recipe | — | Displays the names of the currently selected library, book, and recipe |
| Comment | — | Displays any comments associated with the selected recipe (comments are entered using the Recipe Editor program) |
| Cassette to Use | Cassette 1<br>Cassette 2 | Identifies the cassette to be tested.<br>The Cassette 2 option can only be used with systems configured to support a second cassette. |

**Table 4-7**: Fields and Buttons in the Add Test Window (Continued)

| Field | Options | Description |
|---|---|---|
| Slot # | 1 through 25 | Lists the slots in the current cassette. Slots are numbered from the bottom of the cassette to the top in ascending order. A check mark in the Slot # box indicates that the wafer in that slot will be tested. |
| Wafer ID | user-defined | Identifies the wafer in the slot. The Wafer ID can be edited by double-clicking the ID and entering a new ID in the Wafer ID dialog box. The default Wafer ID identifies the wafer's slot location. Enter only valid alphanumeric characters. Limit Wafer ID length to 30 characters. |

## Editing a QOI Automator Script File

Open the script file as follows:

1. From the File menu of the QOI Automator window, select Open.
2. Select the desired file and click Open.

   The default script directory is C:\Quantox\Scripts, and the file's extension should be `.qas`.

### Editing a Test in the Script File

To edit a test:

1. Highlight the test in the list of Tests to Run and click the Edit button.

   The Edit Test window opens. The Edit Test window is virtually identical to the Add Test window.
2. Edit the test as described beginning on page 4-23.

### Changing the Testing Order

To change the testing order:

1. In the Tests to Run list, highlight the test to be moved.
2. Click either the Move Up or Move Down button to move the test up or down in the list.

### Removing a Test from the Script File

To remove a test from the Tests to Run list:

1. Highlight the test in the list of Tests to Run, and click the Delete button.
2. A confirmation dialog box opens.
   - To delete the test run, click OK.
   - To cancel the delete action, click Cancel.

   The display returns to the QOI Automator window.

### Saving the Edited Script File

To save the script file:

1. From the File menu of the QOI Automator window, click Save or Save As.
2. Enter a name into the File name: field and click Save.

## Running an Automator Script File

To run a script file:

1. Make sure the tool is initialized. If not, run Quantox Startup from the Quantox program group. Wait for Quantox Startup to complete tool initialization.
2. Start the QOI Automator if it is not already running.
3. From the File menu, open the `.qas` file to be used.
4. Select a starting point for the test run. (The run does not have to start with the first test in the Tests to Run list.)

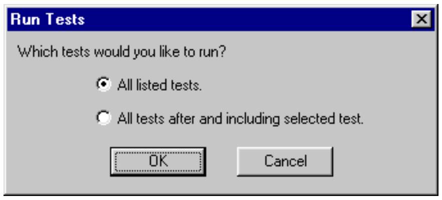
---

**NOTE**

Remember that the testing order can be changed using the Move Up or Move Down button. Refer to "Changing the Testing Order" on page 4-27 for instructions.

---

5. Click the Run Tests button. The Run Tests dialog box shown in Figure 4-18 opens.
   - Clicking the All listed tests button runs all tests in the list, regardless of the selection made in the Tests to Run list box.
   - Clicking the All tests after and including selected test button runs the selected test and all tests listed after it.



Which tests would you like to run?

● All listed tests.

○ All tests after and including selected test.

**Figure 4-18**: Run Tests Dialog Box

6. Click OK to start testing. (Click Cancel to cancel the operation.)

   The QOI Automator window closes, and the Test in Progress window opens in the upper left-hand corner of the screen (Figure 4-19). If necessary, the Automator can be stopped by clicking the Abort button in this window.

<<<<AUTOMATED TESTS IN PROGRESS>>>>

**Figure 4-19**: Test In Progress Window

When testing begins, QOI starts up if it is not already running. QOI Automator uses QOI just as an operator would: clicking buttons, entering text into edit boxes, and so on.

If an error occurs during testing, a detailed error message is displayed. All actions of QOI Automator, including errors, are logged.

---

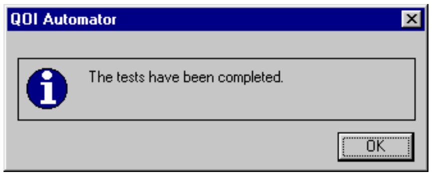
**NOTE**

Once testing has started from the Automator, if any other software is accessed, the Automator flags an error and testing stops after the current test run.

If the Script file contains a recipe that has never been run using QOI, the software will issue an error message that it cannot find the recipe. To correct this error, either go through QOI to refresh the subdirectories, or close and reopen QOI.

---

7. Upon successful completion of the test script, the Tests Completed message box opens (Figure 4-20). Click OK.



The tests have been completed.

**Figure 4-20**: Tests Completed Message

# Pausing the Automator

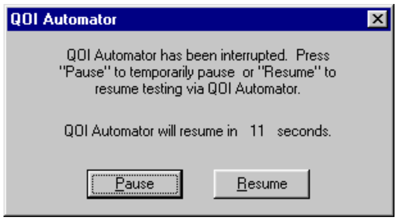
The Automator can be paused, if necessary, to check the progress of a measurement (with Report Generator) or to run another program. After pausing the QOI Automator, testing can be resumed or canceled.

## Pausing the QOI Automator

To pause the Automator:

1. Minimize the QOI window by clicking the minimize icon ( 🗕 ) in the upper right-hand corner of the window.

   The QOI Automator dialog box (Figure 4-21) opens in about 10 seconds.



QOI Automator has been interrupted. Press "Pause" to temporarily pause or "Resume" to resume testing via QOI Automator.

QOI Automator will resume in 11 seconds.

**Figure 4-21**: QOI Automator Dialog Box

2. Click Pause.

   The Test in progress window is replaced with the Automated Tests Paused window (Figure 4-22). Note that if a test is running at the time the Operator clicks Pause, the Automator completes the test before pausing.

>>>>AUTOMATED TESTS PAUSED<<<<

**Figure 4-22**: Automated Tests Paused Window

---

**NOTE**

Bringing up any window in front of the QOI pauses the Automator.

## Resuming Testing

To restart the Automator after pausing it, click Resume in the Automated Tests Paused window. The paused script resumes from the point where it was interrupted. It initially takes 30 to 40 seconds for Automator to resynchronize with QOI. When Automator is resynchronized, one of the following things happens, depending on the current state of QOI:

- If a test is not currently running and the Test in Progress window in QOI is not visible, Automator returns QOI to the Select Cassette page and reenters/restarts the interrupted test run.
- If a test just completed, Automator resumes testing starting with the test run after the interrupted test run.
- If a test is running, or if a test is running and a second test was queued using second cassette queuing, Automator waits until all initiated tests are complete, then resumes testing starting with the test after the one that was interrupted.

**NOTE**

Tests continue to run in QOI while QOI Automator is paused. Pausing the Automator ***only*** pauses the script, not the running recipe. Additionally, QOI Automator can be resumed ***while*** a test is running in QOI. When QOI completes its test, the Automator resumes testing where it left off when it was paused.

## Canceling the Script

To cancel a script after pausing it, click Abort.

## More on Running and Canceling Tests

If QOI Automator testing is stopped, either by an error or by user intervention, such as clicking the Abort button, ***only*** the QOI Automator is stopped. The Quantox Operator Interface is not directly affected. If a test has already been initiated, and QOI Automator stops for a reason that does not involve errors preventing the completion of the test, the test runs to completion. However, any remaining tests in the script are canceled, as Automator has stopped interacting with QOI.

---

**NOTE**

QOI Automator saves the last set of tests used in the file C:\Quantox\Scripts\####.qas. If you wish to use the contents of this file, you must:

1. Make sure that automated testing is not in progress.
2. Load the file ####.qas into QOI Automator using the Open option of the File menu.
3. Save the file under a different name using the Save As option of the File menu.

You can now use the file under its new name.

---

## Exiting QOI Automator

To exit QOI Automator:

1. Select Exit from the File menu of the main QOI Automator window.
2. If you have modified and not saved the current script file, the Save Changes dialog will appear:
   - Select Yes to save the changes.
   - Select No to discard the changes and exit QOI Automator.
   - Select Cancel to return to the QOI Automator window.

# Chapter 5
# Report Generator

When the Quantox system completes a test, the test data is broken down and saved in different test information tables of the Quantox database. Each database table uses a key piece of test information, such as testrun_id, as the basis for each of the separate databases. The information stored in the database can then be retrieved by the Report Generator program.

This chapter describes

# Starting the Report Generator

The Report Generator program is accessed from the Windows NT Start menu by selecting Programs | Quantox | Report Generator. When the program starts the main Report Generator window opens (Figure 5-1). The window is divided into three panes:

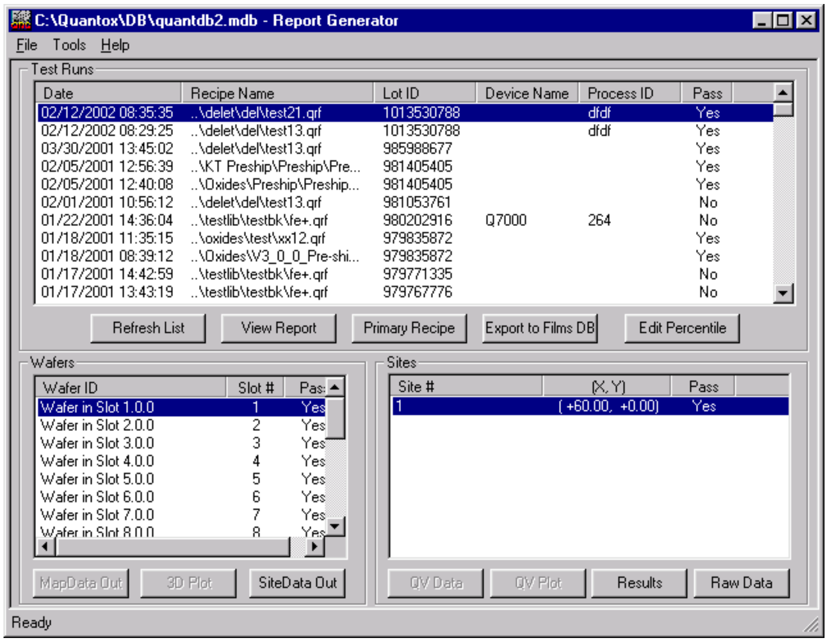
- Test Runs describes all the test runs performed
- Wafers describes all wafers in the currently selected test run
- Sites describes all test sites on the currently selected wafer.

**NOTE**

Quantox Database connectivity in software versions prior to version 3.2 were based on Open Database Connectivity (ODBC) connections. If using the Report Generator to access data collected with a Quantox software version prior to version 3.2, refer to “Managing the Quantox Databases” on page B-15 before launching the Report Generator.

**NOTE**

To access the database, users must have write access to the directory that the database resides in.



| Date | Recipe Name | Lot ID | Device Name | Process ID | Pass |
|---|---|---|---|---|---|
| 02/12/2002 08:35:35 | ..\delet\del\test21.qrf | 1013530788 |  | dfdf | Yes |
| 02/12/2002 08:29:25 | ..\delet\del\test13.qrf | 1013530788 |  | dfdf | Yes |
| 03/30/2001 13:45:02 | ..\delet\del\test13.qrf | 985988677 |  |  | Yes |
| 02/05/2001 12:56:39 | ..\KT Preship\Preship\Pre... | 981405405 |  |  | Yes |
| 02/05/2001 12:40:08 | ..\Oxides\Preship\Preship... | 981405405 |  |  | Yes |
| 02/01/2001 10:56:12 | ..\delet\del\test13.qrf | 981053761 |  |  | No |
| 01/22/2001 14:36:04 | ..\testlib\testbk\fe+.qrf | 980202916 | Q7000 | 264 | No |
| 01/18/2001 11:35:15 | ..\oxides\test\xx12.qrf | 979835872 |  |  | Yes |
| 01/18/2001 08:39:12 | ..\Oxides\V3_0_0_Pre-shi... | 979835872 |  |  | Yes |
| 01/17/2001 14:42:59 | ..\testlib\testbk\fe+.qrf | 979771335 |  |  | No |
| 01/17/2001 13:43:19 | ..\testlib\testbk\fe+.qrf | 979767776 |  |  | No |

| Wafer ID | Slot # | Pas |
|---|---|---|
| Wafer in Slot 1.0.0 | 1 | Yes |
| Wafer in Slot 2.0.0 | 2 | Yes |
| Wafer in Slot 3.0.0 | 3 | Yes |
| Wafer in Slot 4.0.0 | 4 | Yes |
| Wafer in Slot 5.0.0 | 5 | Yes |
| Wafer in Slot 6.0.0 | 6 | Yes |
| Wafer in Slot 7.0.0 | 7 | Yes |
| Wafer in Slot 8.0.0 | 8 | Yes |

| Site # | (X, Y) | Pass |
|---|---|---|
| 1 | ( +60.00, +0.00) | Yes |

**Figure 5-1**: Report Generator Main Window

**NOTE**

Columns within each windowpane can be resized by dragging the border between adjacent column headings.The standard Windows key combinations CTRL-C and CTRL-V can be used to copy and paste data to files in other applications.

# Viewing Test Runs Data

When the Report Generator program starts, it builds a list of all of the test runs in the database and displays the list in the Test Runs pane. Test Runs information includes: test date, recipe name, lot ID, device name, process ID, and the test's pass/fail status.

To view details on a specific test run, scroll through the list to locate the desired test run, and click the test run to select it:

- The Wafers pane updates to describe the wafers tested in the selected run.
- The Sites pane updates to describe the test sites on the selected wafer.

The Test Runs provides three buttons: Refresh List, View Report, and Primary Recipe.

## Refresh List

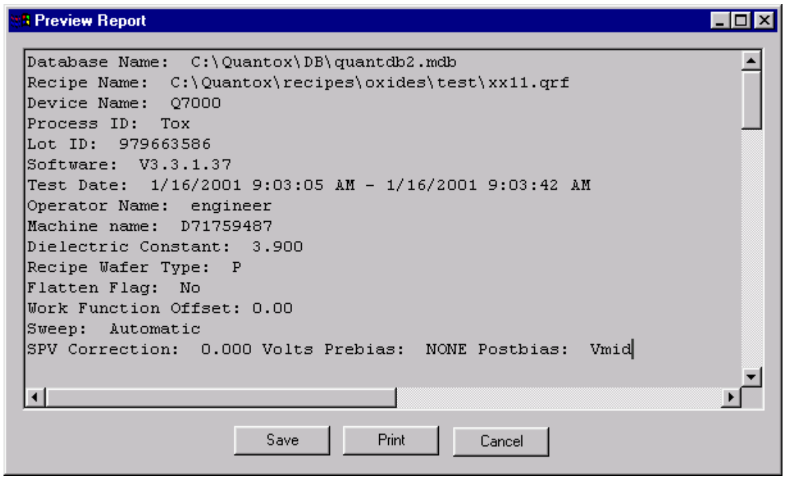
Clicking **Refresh List** forces the Report Generator program to rescan the database and update the Test Runs window. Any test run completed after the Report Generator program was started is now included in the Test Runs display.

## View Report

Clicking **View Report** generates a report of the currently selected test run. The Preview Report window opens to display the test report (Figure 5-2). Use the vertical and horizontal scroll bars to view the entire report.

The Preview Report window provides three buttons:

- Save: saves the report to a text file.
- Print: formats the report and sends it to a printer.
- Cancel: discards the report and closes the window.



```
Database Name:  C:\Quantox\DB\quantdb2.mdb
Recipe Name:  C:\Quantox\recipes\oxides\test\xx11.qrf
Device Name:  Q7000
Process ID:  Tox
Lot ID:  979663586
Software:  V3.3.1.37
Test Date:  1/16/2001 9:03:05 AM - 1/16/2001 9:03:42 AM
Operator Name:  engineer
Machine name:  D71759487
Dielectric Constant:  3.900
Recipe Wafer Type:  P
Flatten Flag:  No
Work Function Offset: 0.00
Sweep:  Automatic
SPV Correction:  0.000 Volts Prebias:  NONE Postbias:  Vmid
```

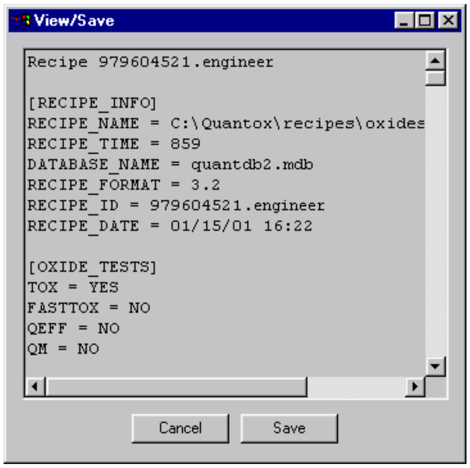
**Figure 5-2**: Preview Report Window

## Primary Recipe

Clicking **Primary Recipe** opens the Recipe View/Save window (Figure 5-3). This window describes the recipe that was used for the currently selected test run. Use the vertical and horizontal scroll bars to view the entire recipe.

The Recipe View/Save window provides two buttons:

- Cancel: closes the window.
- Save: saves the report to a text file.



```
Recipe 979604521.engineer

[RECIPE_INFO]
RECIPE_NAME = C:\Quantox\recipes\oxides
RECIPE_TIME = 859
DATABASE_NAME = quantdb2.mdb
RECIPE_FORMAT = 3.2
RECIPE_ID = 979604521.engineer
RECIPE_DATE = 01/15/01 16:22

[OXIDE_TESTS]
TOX = YES
FASTTOX = NO
QEFF = NO
QM = NO
```

**Figure 5-3**: Recipe View/Save Window

### Edit Percentile

Clicking **Edit Percentile** opens the Additional Percentiles window. For a description of this window, see "Additional Percentiles" on page 3-25.

---

## Viewing Wafer Data

The Wafers pane describes the wafers in the currently selected test run. Information includes: wafer ID, wafer slot location (Slot #), and the wafer's pass/fail status. If the wafer passed all tests, the Pass column displays Yes; if the wafer failed any test, the column displays No. To view wafer information for a different test run, click on the desired test run in the Test Runs pane.

The Wafers pane provides three buttons:

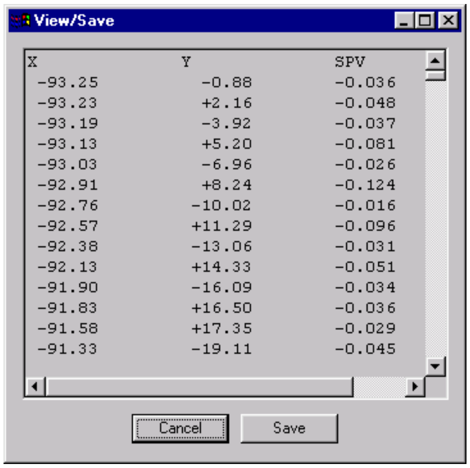
- MapData Out and 3D Plot for map-based measurements
- SiteData Out for site-based measurements

### MapData Out

Clicking the MapData Out button opens the MapData View/Save window (Figure 5-4). This window displays the map data for the selected wafer. Use the scroll bars to view the entire set of data.

The MapData View/Save window provides two buttons:

- Cancel: closes the MapData View/Save window.
- Save: saves the map data to a text file.

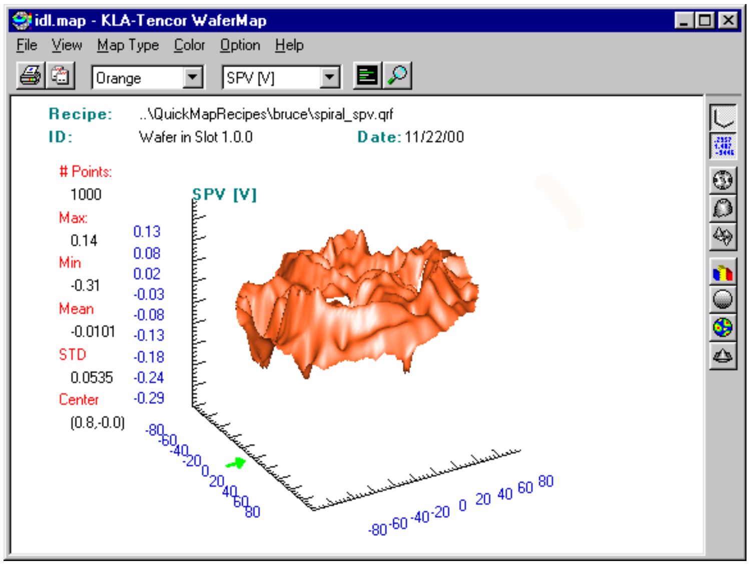


| X | Y | SPV |
|---|---|---|
| -93.25 | -0.88 | -0.036 |
| -93.23 | +2.16 | -0.048 |
| -93.19 | -3.92 | -0.037 |
| -93.13 | +5.20 | -0.081 |
| -93.03 | -6.96 | -0.026 |
| -92.91 | +8.24 | -0.124 |
| -92.76 | -10.02 | -0.016 |
| -92.57 | +11.29 | -0.096 |
| -92.38 | -13.06 | -0.031 |
| -92.13 | +14.33 | -0.051 |
| -91.90 | -16.09 | -0.034 |
| -91.83 | +16.50 | -0.036 |
| -91.58 | +17.35 | -0.029 |
| -91.33 | -19.11 | -0.045 |

**Figure 5-4**: MapData View/Save Window

## 3D Plot

Clicking the 3D Plot button sends the wafer's map data to the 3D plotting program. The 3D program renders the data into a three-dimensional map (Figure 5-5). The data display can be rotated through the full 360 degrees in all axes.



Orange

SPV [V]

Recipe: ..\QuickMapRecipes\bruce\spiral_spv.qrf

ID: Wafer in Slot 1.0.0

Date: 11/22/00

# Points: 1000

Max: 0.14

Min -0.31

Mean -0.0101

STD 0.0535

Center (0.8,-0.0)

**Figure 5-5**: Sample 3D Plot

### Rotating the Display

There are two methods for rotating the display. The first method uses the mouse.

1. Place the mouse over the plot and click and hold.
2. Drag the mouse to rotate the plot to the desired view.

The second method uses the keyboard. Press the following keys to rotate the plot (commands are not case-sensitive):

- J — rotate right
- L — rotate left
- I — rotate up
- M — rotate down
- **,** (comma)— zoom out
- **.** (period)— zoom in

### Menus

The menus in the 3D Plot provide the following functions (shortcut keys, when available, are shown in parentheses).

File menu:

- Open (Ctrl+O): accesses files
- Print (Ctrl+P): prints the plot
- Copy to Clipboard (Ctrl+C): copies the image to the clipboard
- Exit: exits the window

View:

- Toolbar: toggles the display of the toolbars
- Full Screen: expands the plot to cover the entire viewing area
- Display Axis: toggles the display of the axis for the plot
- Display Data: toggles the display of the data values on the plot
- Contour: displays a contour view of the data
- Histogram: displays a histogram of the data
- Skirt: places a skirt around the wafer image

Map Type:

- Next (F7): plots data for the next measurement type (options depend on the type of data that was mapped)
- Previous (F8): plots data for the previous measurement type

Color

- Next (F6): changes the plot color to the next color listed in the drop-down menu (Main toolbar)
- Previous (F5): changes the plot color to the previous color in the drop-down menu
- Black Background: toggles the background color between black and white
- Scaled: displays the wafer image with color scaled to the measurement value

Option

- Change Limits: enables editing of upper and lower scaling limits. An Advanced option enables smoothing of data.

Help

- About WaferViewer: provides version information for the WaferViewer

### Main Toolbar

The Main Toolbar (Figure 5-6) contains the following program controls (many controls are also available from the pull-down menus above the Toolbar):

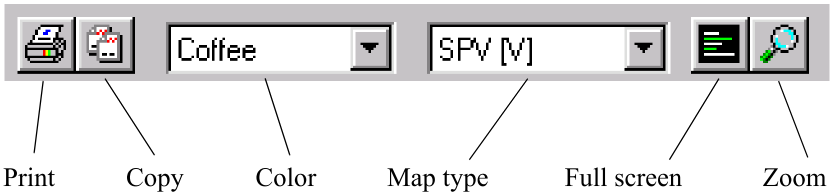


**Figure 5-6**: Main Toolbar

- Print: prints the plot to the system printer
- Copy: copies the current image to the clipboard
- Color: sets the color of the plot
- Map type: selects the type of measurement that will be plotted
- Full screen: expands the plot to cover the entire viewing area.

Note: To return to the normal view from the full screen view, right-click, then deselect Full Screen.

---

- Zoom: displays a slider bar used to change the zoom level of the plot (alternately, the comma and period keys can be used to zooms out or in).

### View toolbar

The View toolbar contains the program controls shown in Figure 5-7. Many of the controls are also available by right-clicking the map.

Axis: toggles the display of the axis for the plot.

Display data: toggles the display of the data values on the plot.

Quick view (top): switches the plot to a top down view.

Quick view (3/4): switches the plot to a 3/4 view.

Quick view (side): switches the plot to a side view.

Histogram: displays a histogram of the wafer data.

Color scale: displays the wafer image color-scaled to the measurement value.

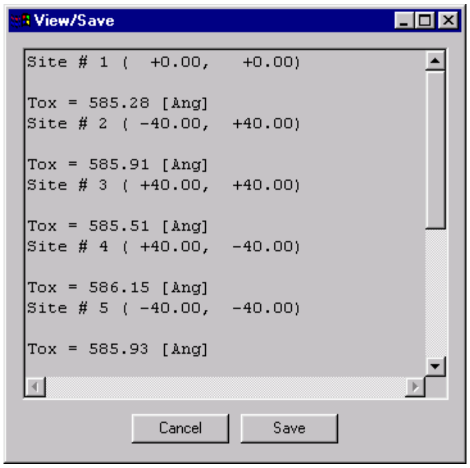
Contour: displays a contour view of the wafer.

Skirt: places a skirt around the wafer image.

**Figure 5-7**: View Toolbar

## SiteData Out

Clicking the SiteData Out button opens the SiteData View/Save window (Figure 5-8). This window displays results of all tests performed on each selected site on the wafer. Use the scroll bars to view the entire set of data.



```
Site # 1 (  +0.00,   +0.00)

Tox = 585.28 [Ang]
Site # 2 ( -40.00,  +40.00)

Tox = 585.91 [Ang]
Site # 3 ( +40.00,  +40.00)

Tox = 585.51 [Ang]
Site # 4 ( +40.00,  -40.00)

Tox = 586.15 [Ang]
Site # 5 ( -40.00,  -40.00)

Tox = 585.93 [Ang]
```

**Figure 5-8**: SiteData View/Save Window

The SiteData View/Save window provides two buttons:

- Cancel: closes the window.
- Save: saves the data to a text file.

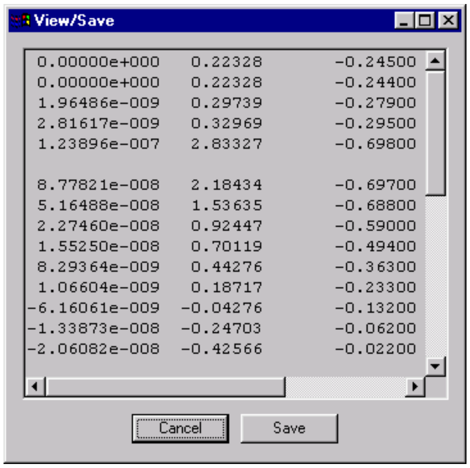
# Viewing Site Data

The Sites pane displays site number, site X and Y coordinates, and the pass/fail status of all sites on the wafer currently selected in the Wafers pane. If a site passed all tests, the Pass column displays ‘Yes’. If a site failed any test, the Pass column displays ‘No’. To view site information for a different wafer, click the desired wafer in the Wafers pane. Site data is only available for site-based measurements.

The Site window provide four buttons: QV Data, QV Plot, Results, and Raw Data.

## QV Data

Clicking the QV Data button opens the QV Data View/Save window shown in Figure 5-9. This window displays the QV data for the currently selected site. Data is arranged in the order [Q-applied, voltage, photovoltage, resistivity (if measured)]. Use the scroll bars to view all the data.



```
 0.00000e+000   0.22328          -0.24500
 0.00000e+000   0.22328          -0.24400
 1.96486e-009   0.29739          -0.27900
 2.81617e-009   0.32969          -0.29500
 1.23896e-007   2.83327          -0.69800

 8.77821e-008   2.18434          -0.69700
 5.16488e-008   1.53635          -0.68800
 2.27460e-008   0.92447          -0.59000
 1.55250e-008   0.70119          -0.49400
 8.29364e-009   0.44276          -0.36300
 1.06604e-009   0.18717          -0.23300
-6.16061e-009  -0.04276          -0.13200
-1.33873e-008  -0.24703          -0.06200
-2.06082e-008  -0.42566          -0.02200
```

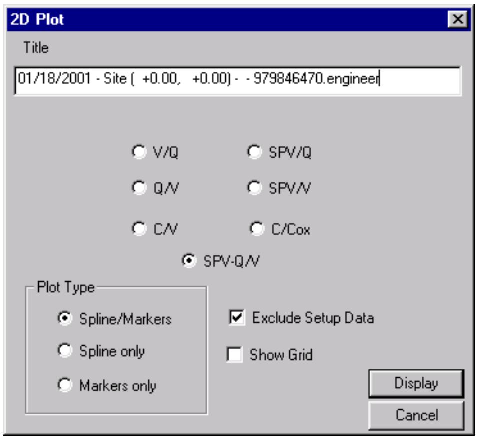
**Figure 5-9**: QV Data View/Save Window

The QV Data View/Save window provides two buttons:

- Save: saves the data to a text file.
- Cancel: closes the window.

# QV Plot

Clicking the QV plot button opens the 2D Plot window (Figure 5-10).



2D Plot

Title

01/18/2001 - Site ( +0.00, +0.00) - - 979846470.engineer

○ V/Q ○ SPV/Q

○ Q/V ○ SPV/V

○ C/V ○ C/Cox

● SPV-Q/V

Plot Type

● Spline/Markers

○ Spline only

○ Markers only

☑ Exclude Setup Data

☐ Show Grid

**Figure 5-10**: 2D Plot Window

This window defines how the data should be plotted. Settings include

- The parameters to be plotted on the X and Y axes.
- Plot type: splines, markers, or both.
- Exclusion of setup data.
- Display of gridlines.

After setting the parameters, click Display to display the Exponent Graphics window (Figure 5-11). To close the Exponent Graphics window, select Exit from the File menu. Click Cancel to close the 2D Plot window.

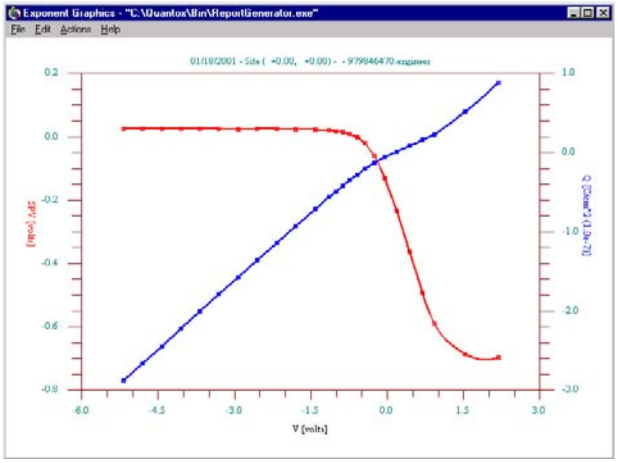
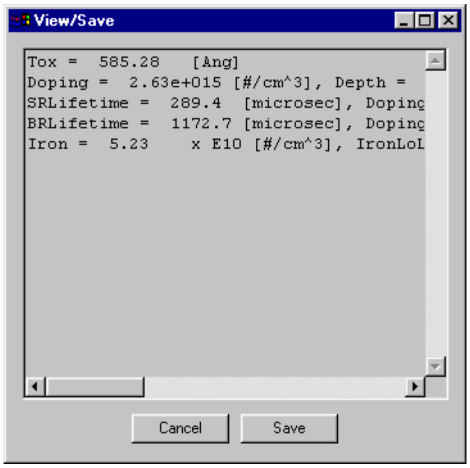


**Figure 5-11**: Exponent Graphics Window

## Results

Clicking the Results button opens the Results View/Save window (Figure 5-12). This window describes tests performed on the selected site and the value obtained by the test. If necessary, use the scroll bars to view all of the data.



```
Tox =  585.28   [Ang]
Doping =  2.63e+015 [#/cm^3], Depth =
SRLifetime =  289.4  [microsec], Doping
BRLifetime =  1172.7 [microsec], Doping
Iron =  5.23    x E10 [#/cm^3], IronLoL
```

**Figure 5-12**: Results View/Save Window

The Results View/Save window provides two buttons:

- Save: saves the data to a text file.
- Cancel: closes the window.

## Raw Data

Clicking the View Raw Data button opens the View Raw Data window shown in Figure 6-12. This shows the types of raw data available. These are doping, surface recombination lifetime (SRLifetime), bulk recombination lifetime (BRLifetime), and iron.

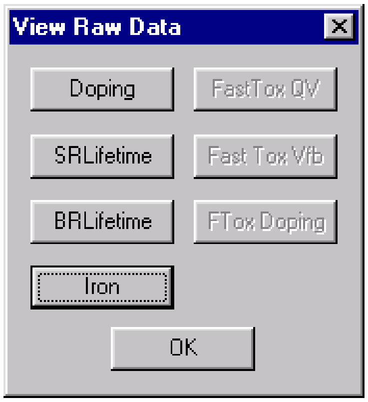
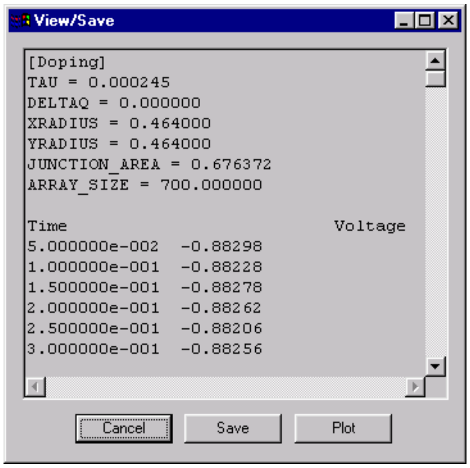


**Figure 5-13**: View Raw Data Window

Clicking one of the active buttons displays the raw data for that test. For example, Figure 5-14 shows the Raw Data View/Save window for Doping. Below the informational header are two columns of data obtained in the doping measurement. The first column is the time in seconds, and the second column is the voltage in volts.



```
[Doping]
TAU = 0.000245
DELTAQ = 0.000000
XRADIUS = 0.464000
YRADIUS = 0.464000
JUNCTION_AREA = 0.676372
ARRAY_SIZE = 700.000000

Time                           Voltage
5.000000e-002  -0.88298
1.000000e-001  -0.88228
1.500000e-001  -0.88278
2.000000e-001  -0.88262
2.500000e-001  -0.88206
3.000000e-001  -0.88256
```

**Figure 5-14**: Raw Data View/Save Window

At the bottom of the window are three buttons:

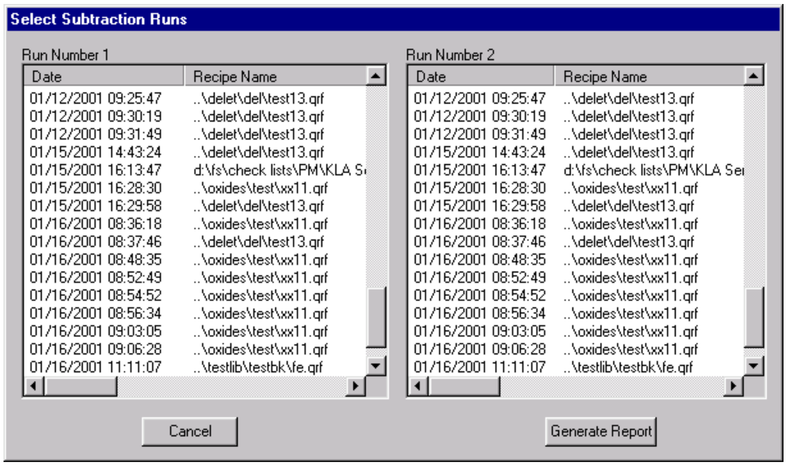
- Cancel: closes the Raw Data View/Save window.
- Save: saves the raw data to a text file.
- Plot: plots the data.

# Using Report Generator Tools

The Tools menu in the Report Generator provides two items: Subtraction report and Options.

## Subtraction Report

The Select Subtraction Runs window (Figure 5-15) enables the user to compare the results of two test runs. The two test runs must be identical, including the wafer IDs, number of wafers, number and location of sites, the map type and size, and test types.



Run Number 1

| Date | Recipe Name |
|---|---|
| 01/12/2001 09:25:47 | ..\delet\del\test13.qrf |
| 01/12/2001 09:30:19 | ..\delet\del\test13.qrf |
| 01/12/2001 09:31:49 | ..\delet\del\test13.qrf |
| 01/15/2001 14:43:24 | ..\delet\del\test13.qrf |
| 01/15/2001 16:13:47 | d:\fs\check lists\PM\KLA S |
| 01/15/2001 16:28:30 | ..\oxides\test\xx11.qrf |
| 01/15/2001 16:29:58 | ..\delet\del\test13.qrf |
| 01/16/2001 08:36:18 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:37:46 | ..\delet\del\test13.qrf |
| 01/16/2001 08:48:35 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:52:49 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:54:52 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:56:34 | ..\oxides\test\xx11.qrf |
| 01/16/2001 09:03:05 | ..\oxides\test\xx11.qrf |
| 01/16/2001 09:06:28 | ..\oxides\test\xx11.qrf |
| 01/16/2001 11:11:07 | ..\testlib\testbk\fe.qrf |

Run Number 2

| Date | Recipe Name |
|---|---|
| 01/12/2001 09:25:47 | ..\delet\del\test13.qrf |
| 01/12/2001 09:30:19 | ..\delet\del\test13.qrf |
| 01/12/2001 09:31:49 | ..\delet\del\test13.qrf |
| 01/15/2001 14:43:24 | ..\delet\del\test13.qrf |
| 01/15/2001 16:13:47 | d:\fs\check lists\PM\KLA Se |
| 01/15/2001 16:28:30 | ..\oxides\test\xx11.qrf |
| 01/15/2001 16:29:58 | ..\delet\del\test13.qrf |
| 01/16/2001 08:36:18 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:37:46 | ..\delet\del\test13.qrf |
| 01/16/2001 08:48:35 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:52:49 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:54:52 | ..\oxides\test\xx11.qrf |
| 01/16/2001 08:56:34 | ..\oxides\test\xx11.qrf |
| 01/16/2001 09:03:05 | ..\oxides\test\xx11.qrf |
| 01/16/2001 09:06:28 | ..\oxides\test\xx11.qrf |
| 01/16/2001 11:11:07 | ..\testlib\testbk\fe.qrf |

**Figure 5-15**: Select Subtraction Runs Window

The Select Subtraction Runs window displays two Run Number boxes. The two boxes display all completed test runs. If a test does not complete for any reason, the run does not display in this dialog box.

To create a subtraction report:

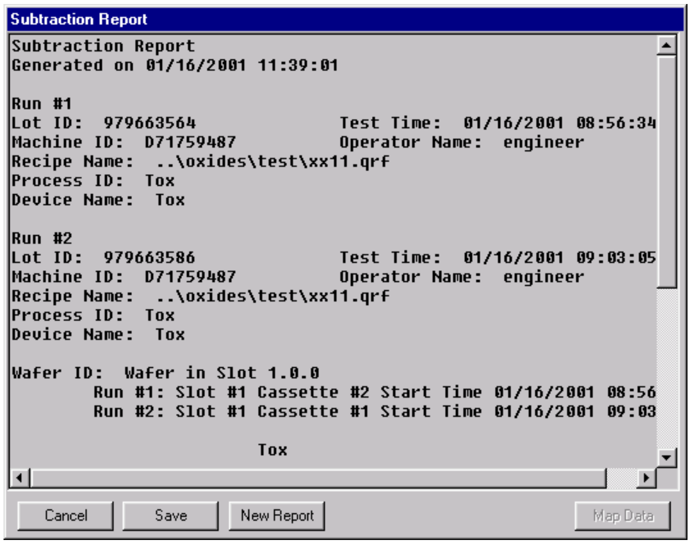
1. Select the tests to be compared: one test in the Run Number 1 box and one test in the Run Number 2 box.

   The test from Run Number 2 is subtracted from the test in Run Number 1.

2. Click the Generate Report button to generate the subtraction report. The system compares the two test runs:

   – If the two test runs match, the system creates a subtraction report (Figure 5-16).

   – If the test runs do not match, the system displays an error message.



```
Subtraction Report
Generated on 01/16/2001 11:39:01

Run #1
Lot ID:  979663564             Test Time:  01/16/2001 08:56:34
Machine ID:  D71759487         Operator Name:  engineer
Recipe Name:  ..\oxides\test\xx11.qrf
Process ID:  Tox
Device Name:  Tox

Run #2
Lot ID:  979663586             Test Time:  01/16/2001 09:03:05
Machine ID:  D71759487         Operator Name:  engineer
Recipe Name:  ..\oxides\test\xx11.qrf
Process ID:  Tox
Device Name:  Tox

Wafer ID:  Wafer in Slot 1.0.0
        Run #1: Slot #1 Cassette #2 Start Time 01/16/2001 08:56
        Run #2: Slot #1 Cassette #1 Start Time 01/16/2001 09:03

                        Tox
```

**Figure 5-16**: Subtraction Report

The Subtraction Report describes the wafers that were compared and displays the subtraction data. The Subtraction Report provides four buttons:

- Cancel: closes the Subtraction Report and returns to the main window of the Report Generator.
- Save: saves the raw data to a text file.
- New Report: returns to the Select Subtraction Runs window
- Map Data: displays a 3D map of the wafer (if the test runs do not contain map data, the Map Data button is disabled).

---

**NOTE**

The difference shown in the subtraction report cannot be correctly validated by subtracting the results of two standard test reports. The precision used in the standard reports might not be high enough to give the correct difference.

---

## Options

The Header and Automation configuration options available from the Tools/Options menu are similar to those in the Quantox Operator Interface. Refer to “Editing the Configuration Options” on page 4-17 for details.

# Chapter 6
# Data Wizard

The Data Wizard program provides a means to analyze data generated by the Quantox system. A plug-in to Microsoft Excel, Data Wizard is accessed from within Microsoft Excel and employs its functionality.

This chapter describes

# Configuring Data Wizard

The Data Wizard configuration option enables the user to define the content and format of the tables and charts produced in Data Wizard. Data Wizard must be configured before being run.

To access the Data Wizard Configuration option:

1. Open Microsoft Excel.

   The menu bar provides two versions of Data Wizard (Figure 6-1):

   – Quantox (version 3.1.2) for databases from Quantox software versions prior to 3.4.3

   – Quantox 3.4.3 (version 3.4.3) for databases from Quantox software versions 3.4.3 and later

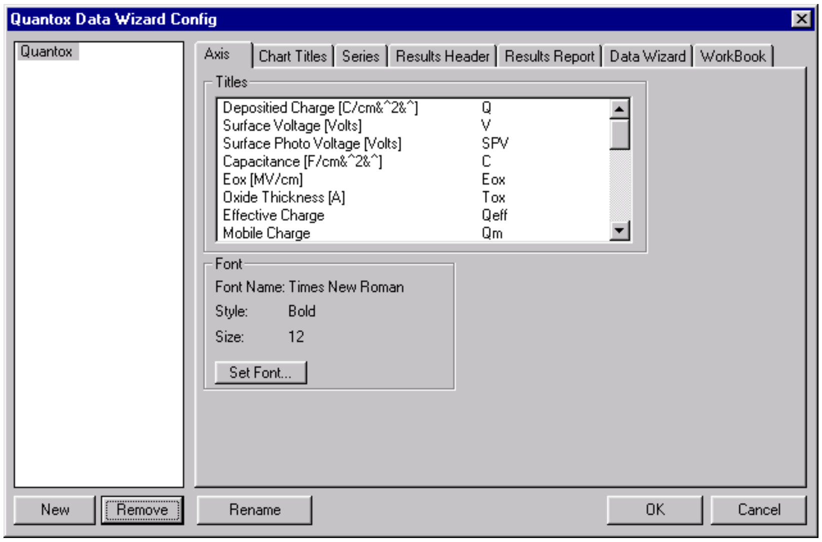
**Figure 6-1**: Quantox Data Wizard Menu Choices

2. From the Quantox 3.4.3 menu, select Configure Quantox Data Wizard.

   The dialog box shown in Figure 6-2 is displayed. The left side of the dialog box lists the current chart descriptions. The right side of the dialog box displays the configuration pages for the selected chart.

**NOTE**

This chapter supports Data Wizard 3.4.3. For additional information on Data Wizard version 3.1.2, refer to Appendix B and to the Quantox Engineering Manual (6400-901-01 Rev G).



| | |
|---|---|
| Depositied Charge [C/cm&^2&^] | Q |
| Surface Voltage [Volts] | V |
| Surface Photo Voltage [Volts] | SPV |
| Capacitance [F/cm&^2&^] | C |
| Eox [MV/cm] | Eox |
| Oxide Thickness [A] | Tox |
| Effective Charge | Qeff |
| Mobile Charge | Qm |

Font Name: Times New Roman

Style: Bold

Size: 12

**Figure 6-2**: Data Wizard Configuration Dialog Box

The Data Wizard Configuration dialog box comprises the following tabbed pages:

- Axis: for defining the chart’s default axis titles and formatting their display
- Chart Titles: for setting title properties for the individual chart types
- Series: for setting display properties for test run series
- Results Header: for selecting the information to be displayed at the top of Site Measurement charts
- Results Reports: for selecting the calculations to be reported on Site Measurement charts
- Data Wizard: for establishing the order in which information is displayed in Data Wizard’s Test Run selection window
- Workbook: for configuring Data Wizard Workbooks.

Buttons at the bottom of the dialog box include

- New: adds a new chart description to the list
- Remove: deletes the selected chart description
- Rename: renames the selected chart description
- OK: ***saves all*** changes and closes the Configuration window
- Cancel: ***discards all*** changes and closes the Configuration window

The following instructions describe how to configure a new Chart Description.

## Creating a Chart Description

The Data Wizard analysis tool can employ multiple chart descriptions. Charts can be configured to display different calculations or to display calculations in different formats.

To create a new chart description:

1. Click the New button.

   The title New Description is added to the list of chart descriptions (Figure 6-2).

2. To give New Description a significant name, click Rename.

   The dialog box shown in Figure 6-3 opens.

Enter Chart Description Name

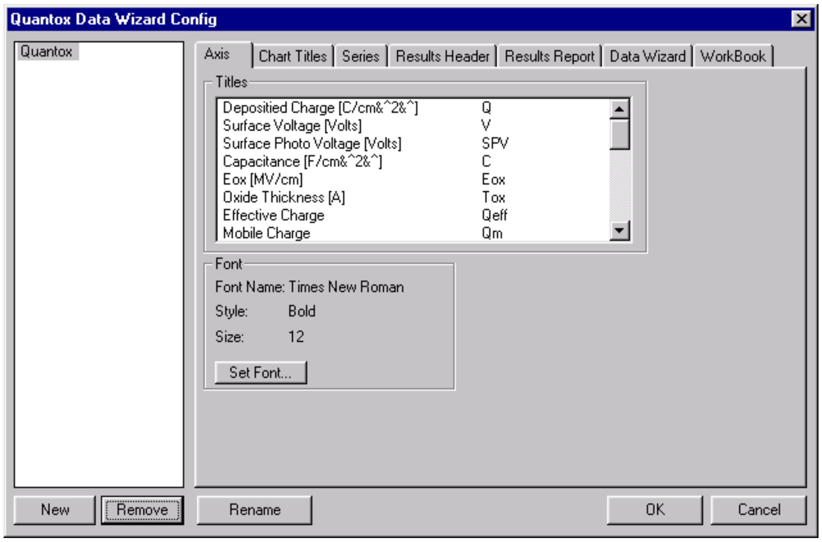
New Description

**Figure 6-3**: Rename Dialog Box

3. Key-in the new name and click OK.

## Editing Axis Titles

The Axis page (Figure 6-4) is used to edit the chart's axis titles and to format the font used in the display of the titles.



| | |
|---|---|
| Depositied Charge [C/cm&^2&^] | Q |
| Surface Voltage [Volts] | V |
| Surface Photo Voltage [Volts] | SPV |
| Capacitance [F/cm&^2&^] | C |
| Eox [MV/cm] | Eox |
| Oxide Thickness [A] | Tox |
| Effective Charge | Qeff |
| Mobile Charge | Qm |

Font Name: Times New Roman

Style: Bold

Size: 12

**Figure 6-4**: Axis Page

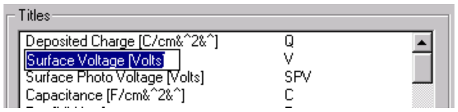
To edit the chart’s axis titles:

1. In the list on the left-hand side of the dialog box, click the chart description to be edited.

   The Axis page displays the axis titles for the selected chart description (Table 6-1 shows the default titles for the symbols).

2. To edit an axis Title, slowly double-click its axis symbol.

   The text box and cursor become active.



| | |
|---|---|
| Deposited Charge [C/cm&^2&^] | Q |
| Surface Voltage [Volts] | V |
| Surface Photo Voltage [Volts] | SPV |
| Capacitance [F/cm&^2&^] | C |

3. Key-in the new title and then click elsewhere to deselect the title.

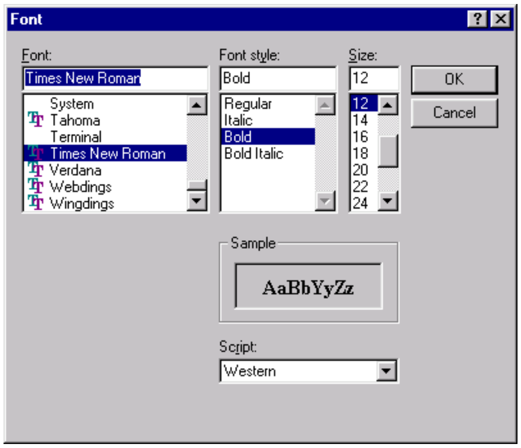
4. Repeat steps 2 and 3 for each title to be edited.

**Table 6-1**: Default Axis Titles

| Axis Titles | Symbol |
|---|---|
| Deposited Charge [C/cm&^2&^] | Q |
| Surface Voltage [Volts] | V |
| Surface Photo Voltage [Volts] | SPV |
| Capacitance [F/cm&^2&^] | C |
| Eox [MV/cm] | Eox |
| Oxide Thickness [Å] | Tox |
| Effective Charge | Qeff |
| Mobile Charge | Qm |
| Oxide Leakage [Ohm-cm] | Leakage |
| Flat Band Voltage [V] | Vfb |
| Doping [#/cm&^3&^] | Doping |
| Midband Voltage [V] | Vmid |
| D^vit^v[#/(eV-cm&^2&^)] | Dit |
| Threshold Voltage [V] | Vt |
| Bulk Recombination Lifetime [microsec] | BR Lifetime |
| Total Charge | Qtot |
| Generation Lifetime [microsec] | G Lifetime |
| Recombination Lifetime [microsec] | SR Lifetime |
| E Tunnel [MV/cm] | E Tunnel |
| Depth | Depth |
| Tau | Tau |
| Initial Voltage [V] | Vo |
| Initial Surface Photo Voltage [V] | SPVo |

To format the font for the axis titles:

1. Click the Set Font button to open the Font window (Figure 6-5).



Font:
Times New Roman

Font style:
Bold

Size:
12

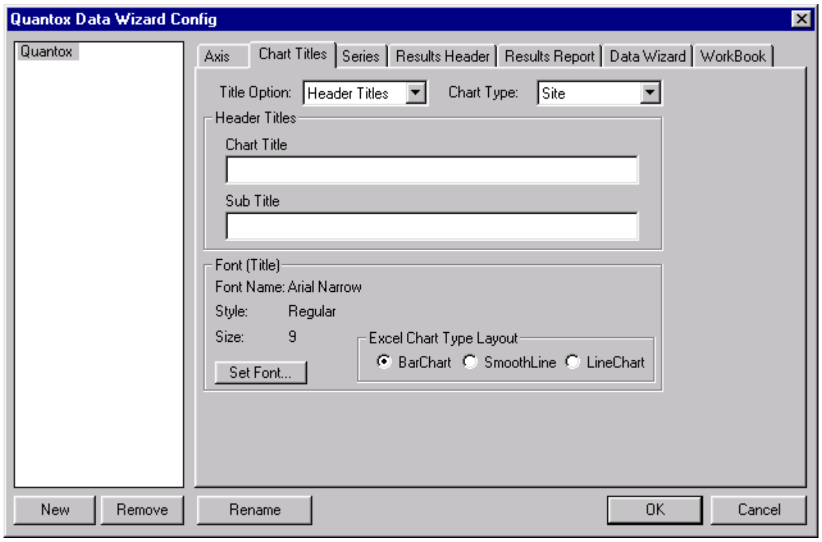
Script:
Western

**Figure 6-5**: Font Window

2. Select the desired font, font style, and size for the axis titles.
3. Click OK to return to the Axis Page.

## Assigning Chart Titles

The Chart Titles page (Figure 6-6) is used to assign titles to the individual chart types: Site, Oxide Trace, and Map.



Title Option: Header Titles

Chart Type: Site

Font Name: Arial Narrow

Style: Regular

Size: 9

Excel Chart Type Layout: ● BarChart ○ SmoothLine ○ LineChart

**Figure 6-6**: Chart Titles Page

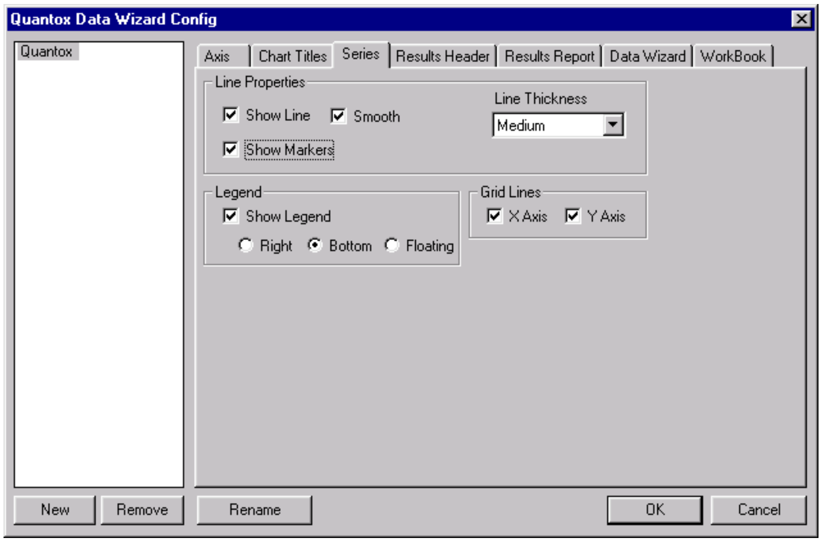
To assign Chart Titles:

1. If the Chart Titles page is not displayed, click the Chart Titles tab.
2. Confirm that the correct chart description is selected.
3. In the Title Option pull-down menu, select Header Titles or Footer Titles (headers appear at the top of the charts; footers appear at the bottom of printouts.)

   The Title fields are customized for the selection.
4. In the Chart Type pull-down menu, select the type of chart that the title should be applied to.
5. Enter the desired titles:
   - for Headers, options include Chart Title and Sub Title.
   - for Footers, options include Left, Center, and Right titles.
6. Click the Set Font… button to open the Font window (Figure 6-5).
7. Select the desired font, style, and size for the selected Title Option and Chart Type, and click OK.
8. Repeat steps 3 through 7 as required to configure header and footer titles for each chart type that uses this chart description.
9. Select the desired Excel Chart layout.

## Selecting Series Properties

The Series page (Figure 6-7) is used to configure the chart display.



Line Properties

☑ Show Line ☑ Smooth

☑ Show Markers

Line Thickness: Medium

Legend

☑ Show Legend

○ Right ● Bottom ○ Floating

Grid Lines

☑ X Axis ☑ Y Axis

**Figure 6-7**: Series Page

To select the series properties:

1. If the Series page is not already displayed, click the Series tab.
2. Confirm that the correct chart description is selected.
3. Select the desired line properties.
4. Indicate if the legend should be displayed and where. The legend lists the test sites and their wafer coordinates.
5. Indicate if X and Y Axis grid lines should be displayed on the charts.

## Defining the Results Header

The Results Header page (Figure 6-8) is used to select the information to be displayed at the top of the Data Summary.

To define the Results Header:

1. If the Results Header page is not already displayed, click the Results Header tab.
2. Confirm that the correct chart description is selected.
3. Click to select the information to be displayed.

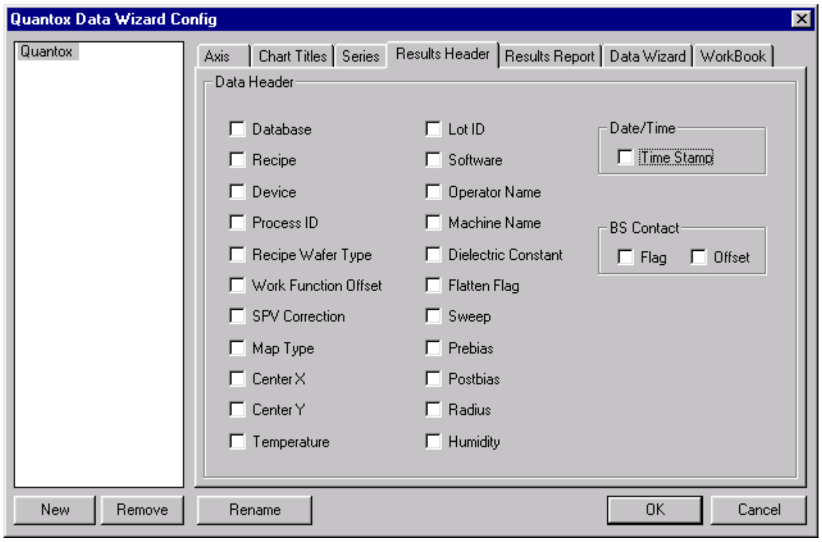
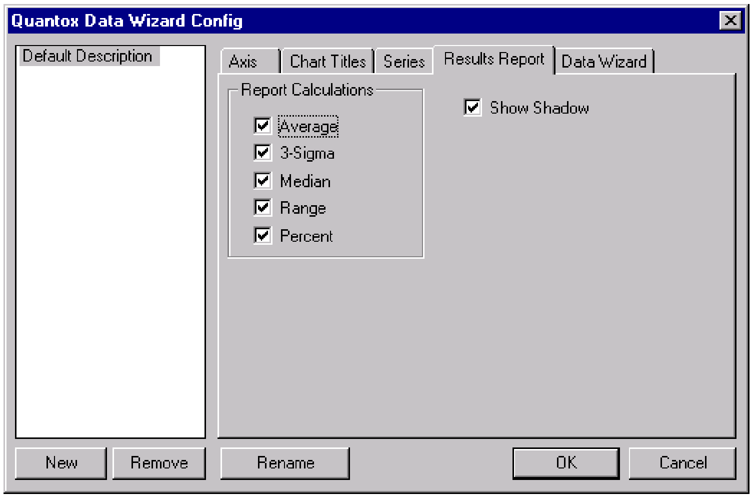


**Figure 6-8**: Results Header Page

## Configuring the Results Report

The Results Report page (Figure 6-9) is used to select the calculations to be reported.



Report Calculations

☑ Average
☑ 3-Sigma
☑ Median
☑ Range
☑ Percent

☑ Show Shadow

**Figure 6-9**: Results Report Page

To configure the Results Report:

1. If the Results Report page is not already displayed, click the Results Report tab.
2. Confirm that the correct chart description is selected.
3. Select the results to be displayed on the reports (refer to the descriptions in Table 6-2).
4. Select which Limits, if any, should be displayed on the report.
5. Check the Show Shadow box to have shadowing applied to the chart.
6. When the configuration is complete, proceed to the next section.

**Table 6-2**: Result Report Calculations

| Measurement Type | Calculation | Description |
|---|---|---|
| Site | Range | Returns the maximum and minimum values for all runs of a given site |

**Table 6-2**: Result Report Calculations (Continued)

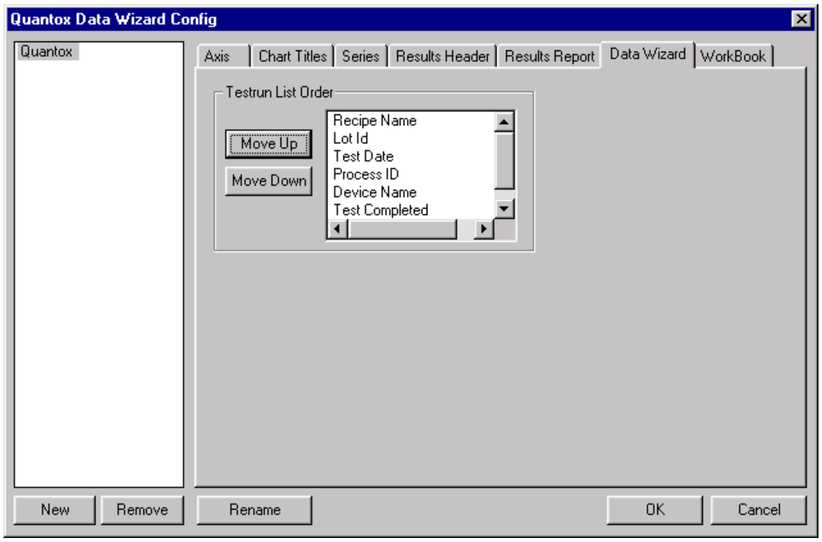
| Measurement Type | Calculation | Description |
|---|---|---|
| | Median | The median of the given numbers. The median is the number in the middle of a set of numbers (in other words, half the numbers have values that are greater than the median and half the numbers have values that are less than the median). If there is an even amount of numbers in the set, the median is calculated by averaging the two numbers in the middle (see second example).<br>Examples:<br>• The median of the values 1, 2, 3, 4, 5 equals 3.<br>• The median of the values 1, 2, 3, 4, 5, 6 equals 3.5 (the average of 3 and 4) |
| | Percent | The absolute value of the 3-sigma value divided by the average<br>ABS(3 * STDEV Value / AVERAGE) |
| | 3-Sigma | Three times the estimated standard deviation based on the run numbers for a given site. The standard deviation is a measure of how widely values are dispersed from the average value (the mean). The standard deviation is calculated using the “nonbiased” or “n-1” method. The following formula is used:<br>$\sqrt{\frac{n\Sigma x^2 - (\Sigma x)^2}{n(n-1)}}$ |
| | Average | The average (arithmetic mean) of all runs for a given site |
| Map | 10th Percentile<br>50th Percentile<br>90th Percentile<br>User Defined | Measurement value where *x*% of the distribution is below that value. |
| | Valid Results | The number of test sites that fell within the valid limits. |
| | Maxima and Minima | The highest and lowest values |

**Table 6-2**: Result Report Calculations (Continued)

| Measurement Type | Calculation | Description |
|---|---|---|
| | Sequence of Multiple Runs | |
| | Mean | Average |
| | Standard Deviation | A measure of how widely values are dispersed from the average value (the mean) |

## Setting the Testrun List Order for Data Wizard

The Data Wizard page (Figure 6-10) is used to set the order in which data columns are displayed in the Select Test Runs dialog box (Figure 6-12). Items ordered from top to bottom in the list are displayed from left to right in the dialog box.



Recipe Name
Lot Id
Test Date
Process ID
Device Name
Test Completed

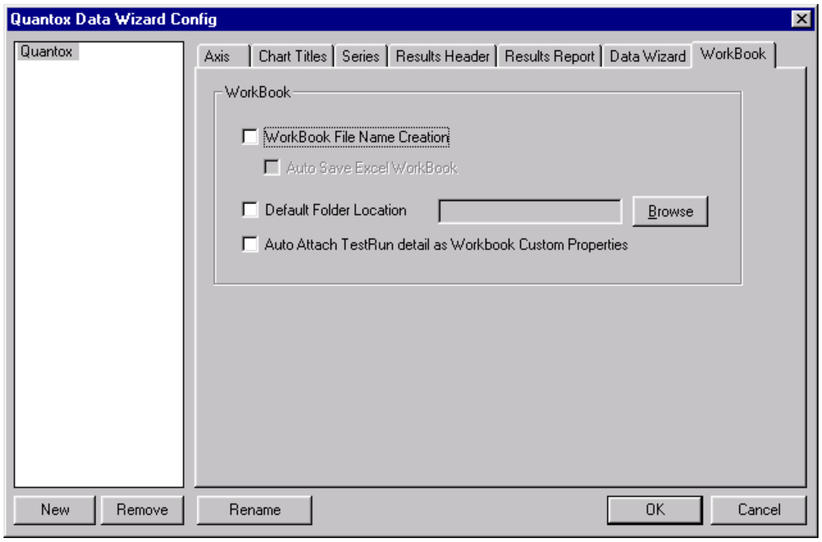
**Figure 6-10**: Data Wizard Page

To set the order of the Data Wizard's Testrun list:

1. If the Data Wizard page is not already displayed, click the Data Wizard tab.
2. Confirm that the correct chart description is selected.
3. Select the item to be moved.
4. Click the appropriate Move button:
   - Click Move Up to move the item towards the top of the list.
   - Click Move Down to move the item towards the bottom of the list.

## Configuring Data Wizard WorkBooks

The WorkBook page (Figure 6-11) is used to select options for saving generated files to a Microsoft Excel workbook.



WorkBook

☐ WorkBook File Name Creation

☐ Auto Save Excel WorkBook

☐ Default Folder Location

☐ Auto Attach TestRun detail as Workbook Custom Properties

**Figure 6-11**: WorkBook Page

To configure the WorkBook:

1. If the WorkBook page is not already displayed, click the WorkBook tab.
2. Confirm that the correct Chart Description is selected.
3. To have Data Wizard prompt the user to save the charts immediately after they are generated, check the WorkBook File Name Creation box.

   Checking the WorkBook File Name Creation box activates the AutoSave Excel WorkBook option. Selecting the AutoSave option instructs Data Wizard to periodically save the workbook.
4. If desired, select a Default Folder Location. The location can be keyed-in or selected using the Browse… button.
5. Indicate if Data Wizard should automatically attach TestRun details to the workbook.

When the configuration is complete, repeat these procedures to configure additional Chart Descriptions or click OK to save the new Chart Description(s) and to close the Data Wizard Configuration window.

# Running Data Wizard

Before running Data Wizard, be sure that the necessary Data Wizard Charts are configured for the Test Runs to be analyzed.

**NOTE**

Although Microsoft Excel tools can be used to modify the charts generated by Data Wizard, the charts must be configured before Data Wizard is run.

To start Data Wizard:

1. Open Microsoft Excel.

   The menu bar provides two versions of Data Wizard (see Figure 6-1):

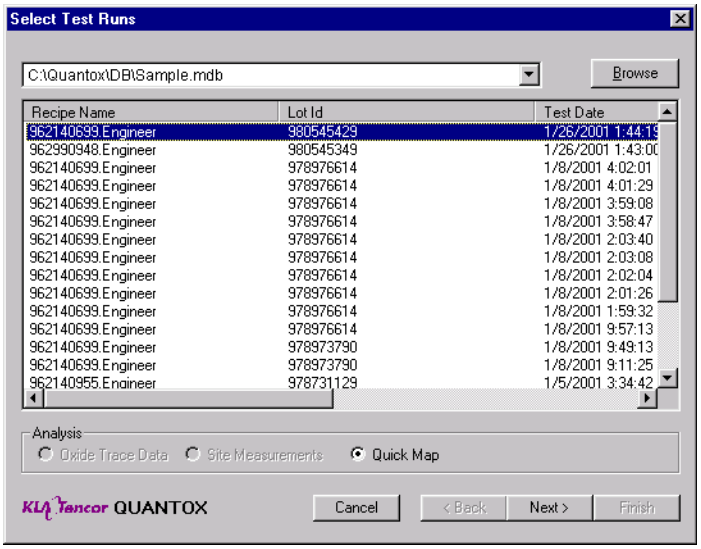
   - Quantox (version 3.1.2) for databases from Quantox software versions prior to 3.4.3
   - Quantox 3.4.3 (version 3.4.3) for databases from Quantox software versions 3.4.3 and later

2. Select Run Quantox Data Wizard from the Quantox 3.4.3 menu.

   Data Wizard displays the Select Test Runs dialog box shown in Figure 6-12. By default, the dialog box opens to the most recently selected database.

**NOTE**

This chapter supports Data Wizard 3.4.3. For details on Data Wizard version 3.1.2, refer to Appendix B and the Quantox Engineering Manual (6400-901-01 Rev G).



C:\Quantox\DB\Sample.mdb

| Recipe Name | Lot Id | Test Date |
|---|---|---|
| 962140699.Engineer | 980545429 | 1/26/2001 1:44:1 |
| 962990948.Engineer | 980545349 | 1/26/2001 1:43:0 |
| 962140699.Engineer | 978976614 | 1/8/2001 4:02:01 |
| 962140699.Engineer | 978976614 | 1/8/2001 4:01:29 |
| 962140699.Engineer | 978976614 | 1/8/2001 3:59:08 |
| 962140699.Engineer | 978976614 | 1/8/2001 3:58:47 |
| 962140699.Engineer | 978976614 | 1/8/2001 2:03:40 |
| 962140699.Engineer | 978976614 | 1/8/2001 2:03:08 |
| 962140699.Engineer | 978976614 | 1/8/2001 2:02:04 |
| 962140699.Engineer | 978976614 | 1/8/2001 2:01:26 |
| 962140699.Engineer | 978976614 | 1/8/2001 1:59:32 |
| 962140699.Engineer | 978976614 | 1/8/2001 9:57:13 |
| 962140699.Engineer | 978973790 | 1/8/2001 9:49:13 |
| 962140699.Engineer | 978973790 | 1/8/2001 9:11:25 |
| 962140955.Engineer | 978731129 | 1/5/2001 3:34:42 |

Analysis
○ Oxide Trace Data ○ Site Measurements ● Quick Map

**Figure 6-12**: Select Test Runs Dialog Box

## Selecting a Database and Data Type

To select a database and the type of data to be analyzed:

1. Select the desired database in one of the following ways:
   - Click the drop-down database menu to choose a previously selected database.
   - Click Browse to locate the database.
   - Key-in the database's path.

---

**NOTE**

If the selected database contains invalid data, Quantox Data Wizard halts and displays an error message. An aborted/incomplete test or corrupted data in the database can trigger an error message.

---

2. Select the test run(s) to analyze (use the scroll bars to display items not currently in view.):
   - Select a single run by clicking it.
   - Select a range of test runs by clicking the first run in the range, holding down the Shift key and clicking the last run in the range.
   - Add a test run to the current selection by holding down the Ctrl-key and clicking the test run (clicking a test run without

holding down the Ctrl-key selects the test run and deselects all other runs.)

3. In the Analysis section of the window, select the data to be analyzed: Oxide Trace Data (QV tests), Site Measurement, or Quick Map.

   Note that only data types pertinent to the selected test runs are available for selection:

   – If the selected test runs only contain wafer map data, Quick Map are the only available selection.

   – If some test runs contain wafer map data and other test runs contain Oxide Trace and Site Measurement data, all data types are available.

4. When the selections are complete, click Next.

   The subsequent display is determined by the type of analysis chosen in step 3. The following sections describe the chart options for the different types of data:

   – "Oxide Trace Data" on page 6-19

   – "Site Measurements" on page 6-21

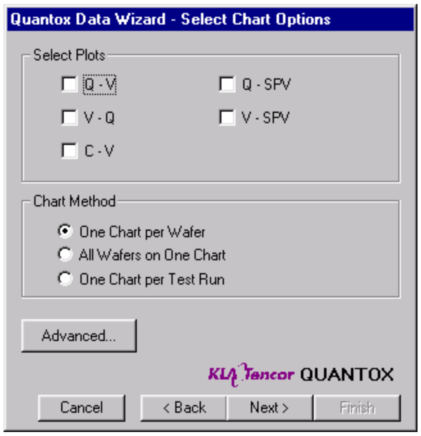
   – "Quick Map" on page 6-22

## Selecting Chart Options

Chart options vary depending on the type of data being analyzed: Oxide Trace, Site Measurement, or Quick Map.

### Oxide Trace Data

When Oxide Trace Data is selected, the Select Chart Options window opens (Figure 6-13).



Quantox Data Wizard - Select Chart Options

Select Plots

☐ Q - V ☐ Q - SPV
☐ V - Q ☐ V - SPV
☐ C - V

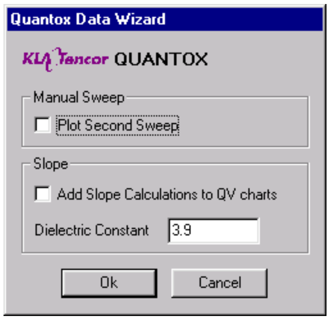
Chart Method

● One Chart per Wafer
○ All Wafers on One Chart
○ One Chart per Test Run

**Figure 6-13**: Select Chart Options for Oxide Trace Data

To select chart options for QV data:

1. Click to select the data to be plotted on the X-Y axes (plots are displayed on separate charts).
2. Select one of the Chart Methods.
3. To add slope calculations to the charts, click the Advanced… button and select the desired option in the dialog box shown in Figure 6-14.



Quantox Data Wizard

Manual Sweep

☐ Plot Second Sweep

Slope

☐ Add Slope Calculations to QV charts

Dielectric Constant 3.9

**Figure 6-14**: Advanced Options for Oxide Trace Data

- Add Slope Calculations to Q-V charts adds a chart to the standard Q-V plot. The slopes are determined by taking four points from the top and four from the bottom of the curve (the two points at the ends are skipped because of possible starting and ending measurement errors). Slope is calculated using built-in Excel functions for the four points for each end of the curve. This returns the slope of the linear regression line through data points in numeric dependent data points and a set of independent data points. The slope is the vertical distance divided by the horizontal distance between any two points on the line, which is the rate of change along the regression line.
- (Manual sweep is not functional in this version of the Quantox Data Wizard.)

Click OK to return to the Select Chart Options window (Figure 6-13).

4. When finished selecting chart options, click Next to open the Select Data to Plot dialog box (Figure 6-15).

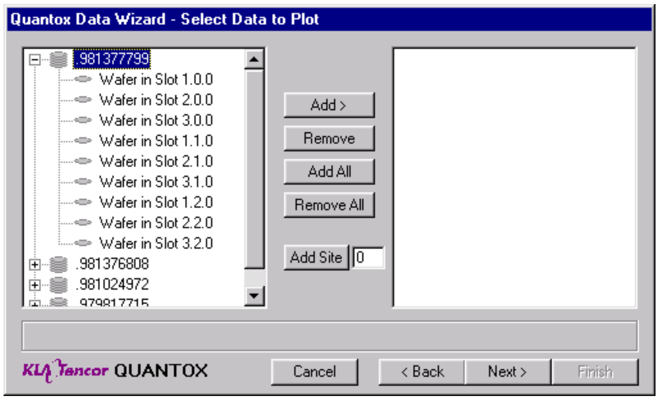
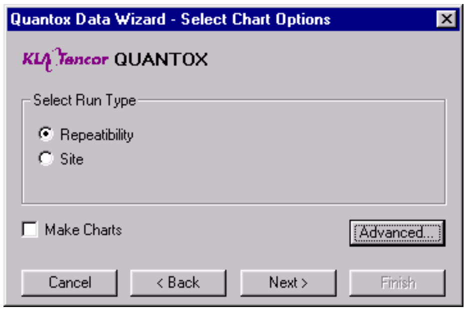


**Figure 6-15**: Select Data to Plot Dialog Box

5. Select the data to be plotted using the appropriate buttons in the dialog box:
   - To select all cassettes, click the Add All button
   - To select an individual cassette or wafer (after expanding the cassette), click the cassette or wafer and then click the Add button.
6. When data selection is complete, click Next to open the Select a Chart Style dialog box (Figure 6-19 on page 6-23).

### Site Measurements

When Site Measurements is selected in the Select Test Runs dialog box (Figure 6-12), the Select Chart Options dialog box opens (Figure 6-16).



Quantox Data Wizard - Select Chart Options

Select Run Type

● Repeatibility

○ Site

☐ Make Charts

**Figure 6-16**: Select Chart Options for Site Measurements

To select chart options for Site Measurements:

1. Select the Run Type to be plotted:
   - Repeatability: the value for each site is plotted vs. run number to enable comparison of several test runs on the wafer
   - Site: the value is plotted vs. site number to enable comparison of all sites on the wafer.

   A separate graph is plotted for each test completed on each wafer. For example, plotting the results of a recipe running three different tests on five wafers produces 15 charts.
2. Check the Make Charts box to have charts made from the analyzed data. If this box is left unchecked, only raw data is reported.
3. To have Secondary Measurement Charts created, click Advanced… , select the secondary chart options (Figure 6-17), then click OK to return to the Select Chart Options window.
4. When finished selecting the Chart Options, click Next to open the Select a Chart Style window (Figure 6-19 on page 6-23).

Quantox Data Wizard

Secondary Measurement Charts

Doping: ☐ Depth

Q Mobile: ☐ Tox, ☐ Leakage

Generation Lifetime: ☐ Doping, ☐ Depth

SRecombination Lifetime: ☐ Doping, ☐ STauR

Tunneling: ☐ Tox, ☐ Qa

BRecombination Lifetime: ☐ Doping

**Figure 6-17**: Secondary Charts for Site Measurement Data

## Quick Map

When Quick Map is selected in the Select Test Runs dialog box (Figure 6-12), the Select Chart Options window opens (Figure 6-18).

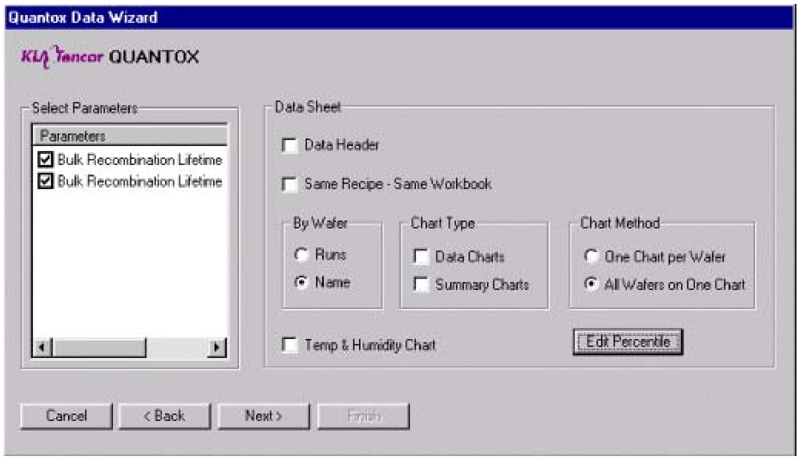


**Figure 6-18**: Select Chart Options for Quick Map

To select chart options for Quick Maps:

1. In the Parameters list, select the type of data to be analyzed.

   If Parameters are not selected, when the Finish button is clicked (Figure 6-19), the system issues an error message and closes Data Wizard.

2. Select the desired Data Sheet options:

   – If Data Header is not checked, the Results Header items selected in "Defining the Results Header" on page 6-10 are not displayed.

   – If a Chart Type is not selected, data are not plotted.

3. When complete, click Next to open the Select a Chart Style window (Figure 6-19).

## Selecting a Chart Style and Generating the Charts

After clicking Next from any of the Chart Option dialog boxes, the Chart Style dialog box opens (Figure 6-19).

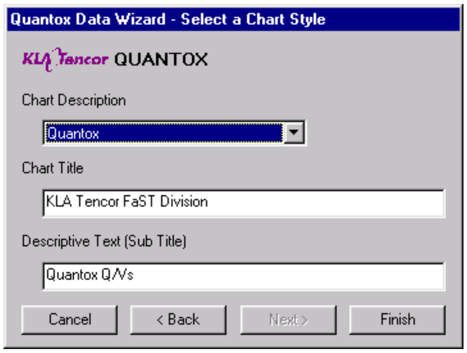


Chart Description: Quantox

Chart Title: KLA Tencor FaST Division

Descriptive Text (Sub Title): Quantox Q/Vs

**Figure 6-19**: Select A Chart Style

To select a chart style and generate the charts:

1. Select the appropriate Chart Description from the pull-down menu.

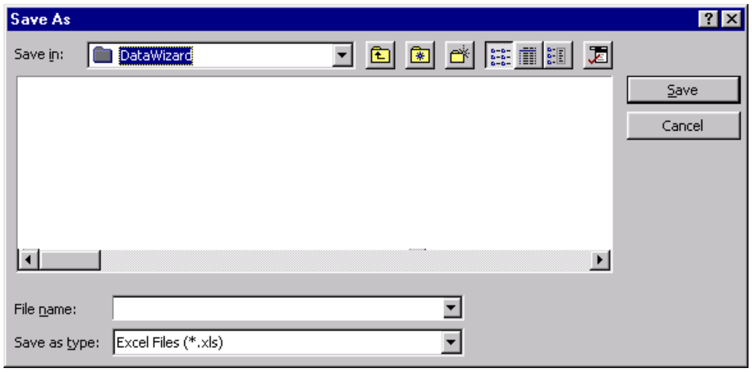
   The Chart Title and Description Text fields display the titles for the selected chart description and data type (as configured in “Assigning Chart Titles” on page 6-8).

2. Click Finish to generate the charts.

   Data Wizard processes the data and displays the charts.

## Reviewing Generated Charts

Depending upon how the Data Wizard Workbook is configured for the selected Chart Description, Data Wizard might display the Save As dialog box.



Save in: DataWizard

File name:

Save as type: Excel Files (*.xls)

**Figure 6-20**: Save As Dialog Box.

After entering the required information, click Save. The Data Wizard Charts can now be reviewed and modified using standard Excel tools. The Site Measurement toolbar (a toolbar option in the View menu) enables you to toggle between site and repeatability data and between bar and line charts.

When the file is closed, if it has never been saved or if it has been modified, Excel prompts the user to save the file.

# Chapter 7
# Database Administration

*Database Administration (DB Admin)* is an umbrella term for the process of administering the Quantox database. DB Admin helps you manage the contents of your database, update it as necessary, and manage the interaction with the Quantox reporting and analysis tools.

This chapter describes

# DB Admin Navigation

The DB Admin feature provides tree-style navigation to the Quantox database. As shown in Figure 7-1, DB Admin includes a Menu bar containing the choices described in Table 7-1.

If DB Admin does not exist as an icon or a menu selection on your system, access it using Windows Explorer and follow the path **Quantox | Bin | DBAdmin.exe**.

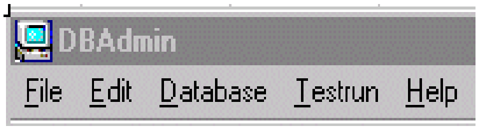


**Figure 7-1**: DB Admin Menu Bar

## DB Admin Menu Bar

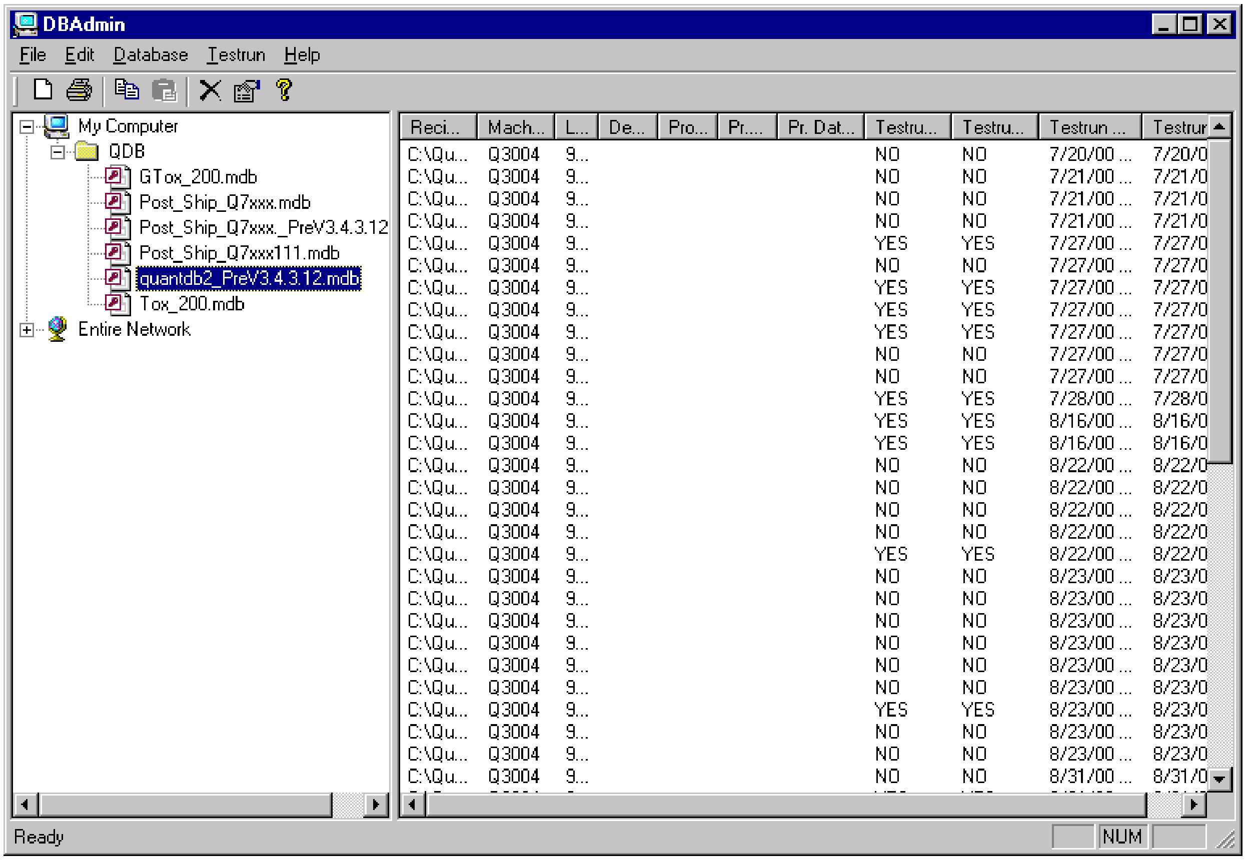
**Table 7-1**: DB Admin Menu Bar Choices

| First Level | Second Level | Description |
|---|---|---|
| File | New | Creates a new instance of the DB Admin application. |
| | Print | Prints the contents of the database with respect to the test run, or prints the information from the test run based on the context. |
| | Exit | Exits DB Admin. |
| Edit | Copy | Copies the test run contents to the clipboard. |
| | Paste | Pastes the test run contents to the clipboard. |
| | Delete | Deletes the test run/database, based on the context, with confirmation. |
| | Printer Font | Displays a font-selection dialog box. |
| Database (enabled when the focus is on the left pane; see Figure 7-2) | Create | Creates a database. |
| | Delete | Deletes the selected database. |
| | Rename | Renames the selected database. |
| | Convert | Converts the selected database to the current version. |
| | Archive | Archives the database in the archive folder. |
| | Compact | Compacts the selected database. |
| | Copy All Test Runs | Copies all test runs in the database to the clipboard. |
| | Print All Test Runs | Prints all test runs in the database to the printer. |
| | Properties | Displays a Database Properties page containing database information, as shown in Figure 7-3. |

**Table 7-1**: DB Admin Menu Bar Choices (Continued)

| First Level | Second Level | Description |
|---|---|---|
| Test Run (enabled when the focus is on the right pane; see Figure 7-2) | Copy | Copies the selected test run to the clipboard. |
| | Paste | Pastes the test runs from the clipboard. |
| | Delete | Deletes the selected test runs. |
| | Print | Prints the selected test runs. |
| | Properties | Displays a property page containing the test run information. |
| Help | About | Displays information about the current version of the software. |

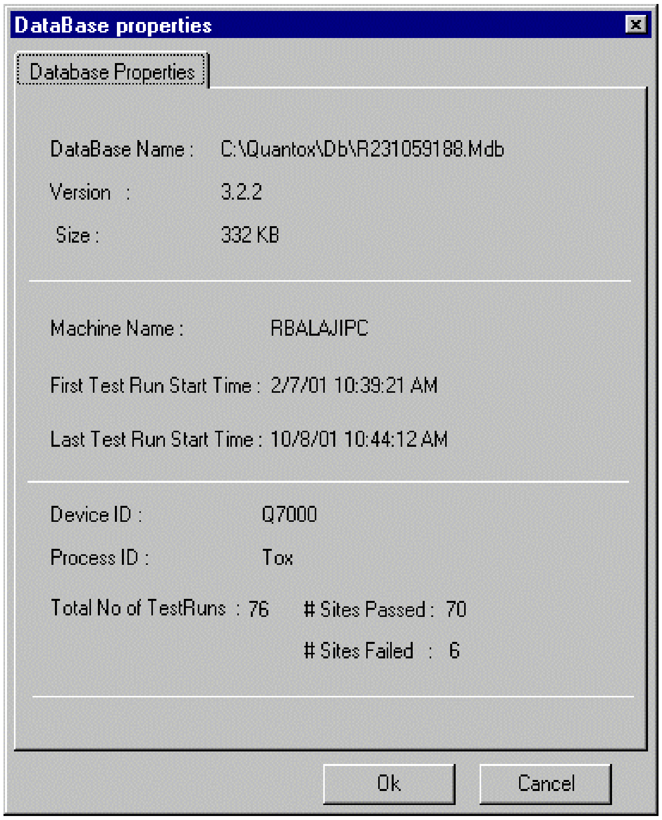
Figure 7-2 shows the Quantox DB Administrator (DB Admin) window. The Database pane is at the left; the Test Run pane is at the right.



| Reci... | Mach... | L... | De... | Pro... | Pr.... | Pr. Dat... | Testru... | Testru... | Testrun ... | Testru |
|---|---|---|---|---|---|---|---|---|---|---|
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/20/00 ... | 7/20/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/21/00 ... | 7/21/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/21/00 ... | 7/21/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/21/00 ... | 7/21/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 7/27/00 ... | 7/27/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 7/28/00 ... | 7/28/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 8/16/00 ... | 8/16/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 8/16/00 ... | 8/16/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/22/00 ... | 8/22/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/22/00 ... | 8/22/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/22/00 ... | 8/22/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/22/00 ... | 8/22/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 8/22/00 ... | 8/22/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | YES | YES | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/23/00 ... | 8/23/0 |
| C:\Qu... | Q3004 | 9... | | | | | NO | NO | 8/31/00 ... | 8/31/0 |

**Figure 7-2**: DB Admin Window

Figure 7-3 shows the Database Properties information window referred to under “Properties” in Table 7-1.



DataBase Name : C:\Quantox\Db\R231059188.Mdb
Version : 3.2.2
Size : 332 KB

Machine Name : RBALAJIPC
First Test Run Start Time : 2/7/01 10:39:21 AM
Last Test Run Start Time : 10/8/01 10:44:12 AM

Device ID : Q7000
Process ID : Tox
Total No of TestRuns : 76
# Sites Passed : 70
# Sites Failed : 6

**Figure 7-3**: Database Properties Information Window

## DB Toolbar

The DB Admin Toolbar, shown in Figure 7-4, contains icons for the functions described in Table 7-2.

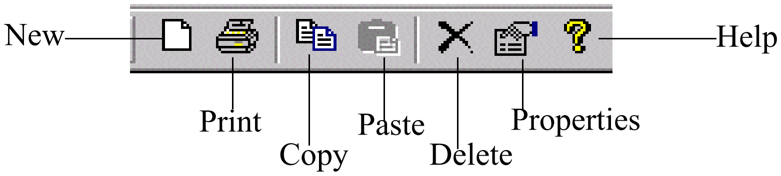


**Figure 7-4**: DB Admin Toolbar

**Table 7-2**: DB Admin Toolbar Choices

| Choice | Description |
|---|---|
| New | Starts a new instance of the application. |
| Print | Prints the information from the selected database or test run, depending on context. |
| Copy | Copies the test run contents to the clipboard. |
| Paste | Pastes the test run contents from the clipboard. |
| Delete | Deletes the selected database or test run, depending on context. |
| Properties | Displays the selected database properties or test run properties in a property page, depending on the context. |
| Help | Displays an About dialog box. |

# Using DB Admin

This section describes using DB Admin to access and manipulate Quantox databases, and database operations on test runs.

## Accessing and Manipulating Databases

DB Admin lists all Quantox databases in your system, starting the navigation at the %QDB% (the Quantox Database path) Environment variable only for local databases. To access a database, select in in the left pane. Select only one database at a time; multi-selection is not allowed.

The DB Admin user interface (UI) also allows access to databases in the Windows Network Neighborhood—in read-only mode—by selecting them in the left pane. Again, select only one database at a time; multi-selection is not allowed. When a database is selected, the UI lists database information with respect to the test run in the right pane. This information comprises the following:

- Recipe Path
- Machine Name
- Lot ID
- Device ID
- Process ID\Process Name
- Process Equipment Name
- Process Date & Time
- Test Run Completed flag
- Test Run Passed flag
- Test Run Start Time
- Test Run End Time

### Sorting the DB Columns

To sort any column reported in the Test Run display (in ascending or descending order), click the column in the right pane.

### Creating a Database

To create a new database

- Choose **Database | Create** on the menu bar. Or
- Right-click the Quantox Directory. Then choose **Create** on the pop-up menu.

### Deleting a Database

To delete a database

- Choose **Database | Delete** on the menu bar. Or
- Click the **Delete** icon on the toolbar.

In either case, the question "Are you Sure you want to remove the selected database?" appears. Choose **Yes**.

### Archiving a Database

To archive a database

- Choose **Database | Archive** on the menu bar. Or
- Right-click the database and choose **Archive** on the pop-up menu.

### Copying Test Run Data to the Clipboard

To copy test run data to the clipboard

- Choose **Database | Copy** on the menu bar. Or
- Right-click the database and choose **Copy** on the pop-up menu. Or
- Click the **Copy** icon on the toolbar.

  Once the test run data is copied to the clipboard, it can be copied locally to any database.

### Printing Database Contents

To print the database contents

- Choose **File | Print** on the menu bar. Or
- Right-click the database and choose **Print** on the pop-up menu. Or
- Click the **Print** icon on the toolbar.

### Compacting the Database

To make the database occupy less disk space ("compact" it)

- Choose **Database | Compact** on the menu bar. Or
- Right-click the database and choose **Compact** on the pop-up menu.

### Finding Properties Information

To explore properties-related information about the database

- Choose **Database | Properties** on the menu bar. Or
- Right-click the database and choose **Properties** on the pop-up menu.

Properties information (see Figure 7-3) comprises

- Database Name
- Database Version
- File Size
- Machine Name
- First Test Run Start Time
- Last Test Run Start Time
- Device ID
- Process ID\Process Name
- Total number of lots / repeats
- Total number of Test Runs
- Number of Passing and Failing Sites

## Managing Test Runs

Within each individual database, the UI supports the operations described in this section. Choose either individual or multiple test runs.

### Copying and Pasting Test Run Data From One Database to Another

To copy test run data from one database and paste it in another

- Choose **Test Run | Copy/Paste** on the menu bar. Or
- Right-click **Test Run** and choose **Copy/Paste** on the pop-up menu. Or
- Click the **Copy/Paste** icon(s) on the toolbar.

### Deleting Test Runs

To delete a test run (on local databases only)

- Choose **Test Run | Delete** on the menu bar. Or
- Right-click **Test Run**, then choose **Delete** on the pop-up menu. Or
- Click the **Delete** icon on the toolbar.

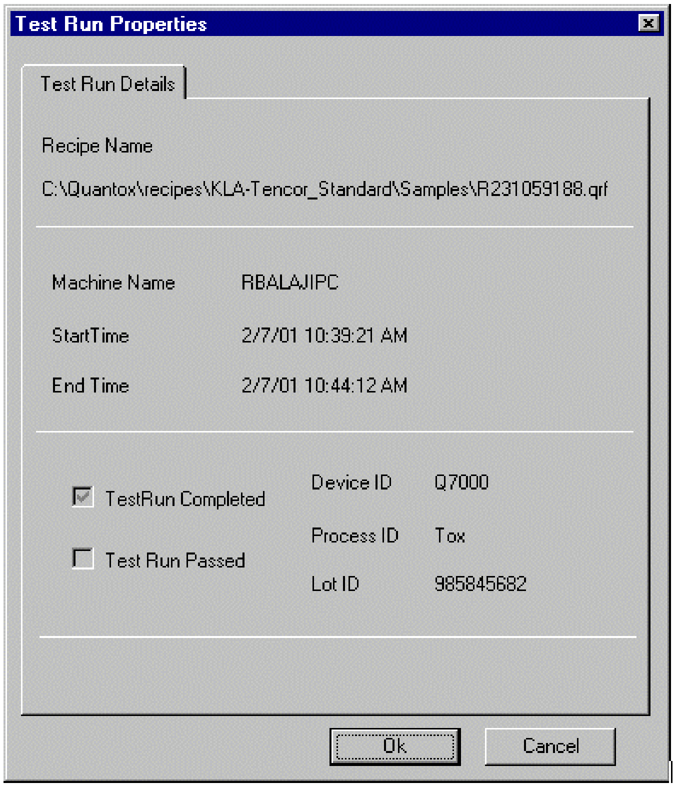
  Whichever method you use, a Confirmation box appears asking you to confirm that you want to delete the test run.

### Dragging and Dropping Test Runs

Using standard mouse drag-drop techniques, you can drag a test run from one database and drop it in another database.

### Printing a Test Run Properties Page

Figure 7-5 shows a Test Run Properties Page.



Recipe Name

C:\Quantox\recipes\KLA-Tencor_Standard\Samples\R231059188.qrf

Machine Name RBALAJIPC

StartTime 2/7/01 10:39:21 AM

End Time 2/7/01 10:44:12 AM

☑ TestRun Completed

☐ Test Run Passed

Device ID Q7000

Process ID Tox

Lot ID 985845682

**Figure 7-5**: Test Run Property Page

As shown, the information on the page comprises the following:

- Recipe Path
- Machine Name
- Lot ID
- Device ID
- Process ID
- Number of Wafers
- Total Number of Sites
- Total Number of Maps
- Test Run Completed flag
- Test Run Passed flag
- Test Run Start Time

- Test Run End Time

To print a Test Run Property page

- Choose **File | Print** on the menu bar. Or
- Right-click **Test Run** and choose **Print** on the pop-up menu. Or
- Click the **Print/Properties** icon on the toolbar.

# Converting to V3.4 from Older Databases

To use V3.4 of the Quantox software, you must convert your databases from MS Office 97 to Office 2000.

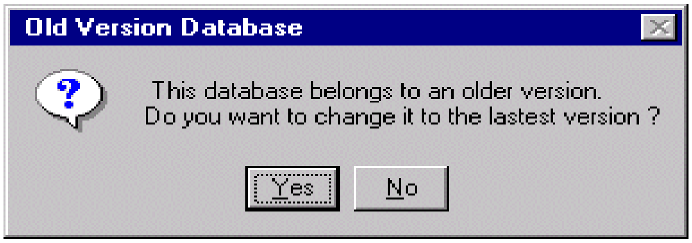
## Constraints, Assumptions, and Limitations

For the conversion to succeed

- ***Only*** Quantox databases can be present in C:\Quantox\db.
- The Network Machine(s) must share their Quantox Database Directory to be listed in DB Admin.
- Operations on the remote databases are limited by the availability of the computer accessed (it must be switched on) and you must provide your KLA-Tencor representative permission to access the database.
- The %QDB% (the Quantox Database Path for the machine) Environment variable can be determined only for local databases and not for remote databases.

## Making the Conversion

When you open a database older than the V3.4 format, the message  in Figure 7-6 appears.


Old Version Database

This database belongs to an older version.
Do you want to change it to the lastest version ?

**Figure 7-6**: DB Conversion Decision Box

To convert it, click **Yes**. To view the database but not convert it, click **No**.

If for some reason the "Old Version Database" message does not appear, and you want to convert a database to the current version,

- Choose **Database | Convert** in the menu bar. Or
- Right-click the database and choose **Convert** in the pop-up menu. Or
- Make the conversion in the **Report Generator** window.

# *Chapter 8*
# *QDoctor*

This chapter describes QDoctor, a utility that monitors the overall health of the Quantox system. (QDoctor is ***not*** intended as a troubleshooting package to isolate and identify a problem, if one exists.)

Each time you run QDoctor, the results are stored in a file that can be used by your KLA-Tencor service representative to observe trends in Quantox performance.

The sections in this chapter comprise

- "QDoctor Tests" on page 8-2
- "Limitations" on page 8-4
- "Running QDoctor" on page 8-5

# QDoctor Tests

QDoctor tests comprise the following:

- Humidity and temperature in the measurement chamber

  Measures the lower instrument chamber temperature and humidity, using the Humitter Sensor. The readings are compared with system specifications.
- Metrabyte Metribite DAS

  Verifies that the voltages in the modules within the Metribite DAS match each other.
- Power supply voltages
- Verifies that the digital power supply outputs for the LD and CO Head Control Modules and the Chuck Control Module are operating correctly.
- Function generator operation

  Verifies the pulse width and height of the system function generator.
- DAC Voltages

  Verifies that the voltages in the digital-to-analog converters in the Chuck Control Module are within specifications.
- Chuck and Outrigger Voltages

  Verifies that the voltages at the chuck and outrigger are within specifications.
- Chuck attenuators

  Verifies that the voltages at the chuck and outrigger are being attenuated correctly.
- Chuck current meters

  Verifies that the current meter connections and outputs works correctly.
- Charge meter

  Verifies that the chuck and outrigger charge-meter circuitry works correctly.
- Panel closure
- Laser output
- LDKP airgap

  Verifies that an LD Kelvin Probe airgap can be set and that the airgap offset voltage is within specifications.

- COKP airgap

  Verifies that an airgap can be set and that the Corona Kelvin Probe airgap offset voltage is within specifications.
- LD preamplifier
- COKP time constant

  Verifies that the function generator time constant is within specifications, using the Corona Kelvin Probe.
- LDKP time constant

  Verifies that the LD time constant is within specifications, using the Kelvin Probe.
- LDCG Qscale

  Verifies that the Corona Gun needles are firing the charge correctly.
- LDCG LED

  Verifies that the drive circuitry works correctly for the LD Corona Gun LED.
- CO Corona profile

  Verifies uniformity of the charge across the outrigger after firing the Corona Gun at selected intervals.
- LDHKP outrigger height
- Xenon flash intensity

  Verifies that the Xenon flash works properly and delivers intensity within specification.
- LDCG voltage vs. current
- COSCG voltage vs. current
- COKP LED

  Verifies that the drive circuitry works correctly for the Corona Kelvin Probe LED.
- COSCG LED

  Verifies that the drive circuitry works correctly for the Corona SCG LED.
- BKSTEP

# Limitations

For a QDoctor analysis to be meaningful

- You must be running Quantox V3.3 or 3.4. (Version 3.3 results should be interpreted by KLA-Tencor Technical Support representatives only.)
- The tool must have both heads in place and be planarized.
- The tool must be able to run low-level tests.
- No other recipe can be running when you run QDoctor.

# Running QDoctor

QDoctor requires no wafers and no equipment outside the Quantox system. Once you start QDoctor, it requires no intervention on your part. The tests take approximately five minutes.

To run QDoctor,

1. In your Field Service (FS) directory, run the program **QDOCTOR.exe**.

   The QDoctor window shown in Figure 8-1 appears.

**Figure 8-1**: QDoctor Window

2. Click **Daily Health Check**.

   As the program runs, a Daily Health Check window appears, showing that the status is running, as shown in Figure 8-2.

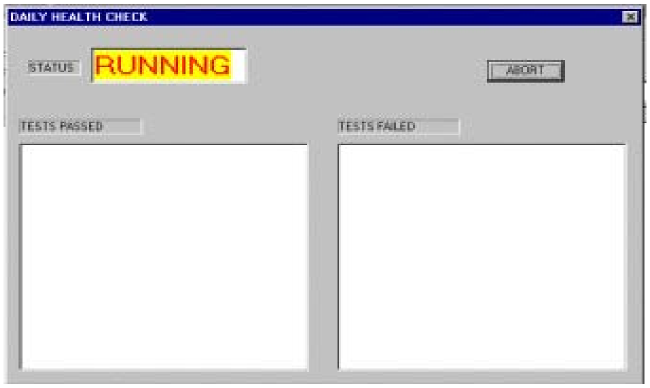


**Figure 8-2**: Daily Health Check Window

If the tests are successful, the program reports “Passed.” If any test fails, the program reports “Failed.”

3. Make a copy of the **healthcheck.mdb** file found in your FS folder. Send it to KLA-Tencor Quantox Tech Support, via the CRC, for review. Include the software version running and whether the system is a 200-mm or 300-mm system.

   If the system throws an error ***while running*** QDoctor, document the error in the message to KLA-Tencor. Include a screen capture of the error message and identify the subtest running at the time.

# Appendix A
# Measurement Theory

The measurement principles employed by the Quantox system are highly analogous to traditional MOS C-V testing with the advantages of non-contacting technology. In the Quantox oxide monitoring system, three non-contacting techniques are combined to perform the measurement functions shown in Figure A-1.

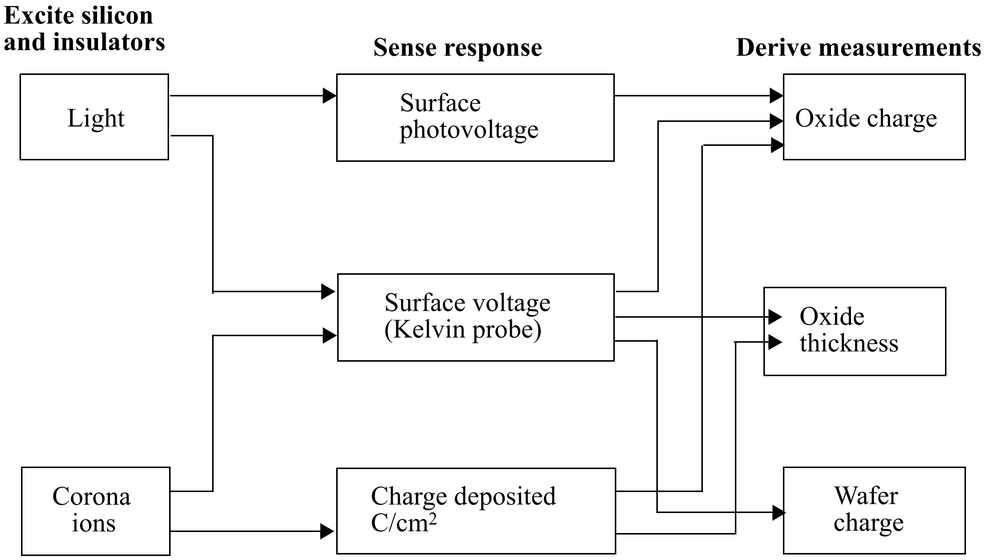


**Figure A-1**: Quantox Measurement Technology

The operational components of Quantox include corona sources, a capacitively-coupled voltage measurement device (Kelvin probe), and surface photovoltage instrumentation using a laser or LED:

- Charged corona ions provide biasing and emulate the function of the MOS electrical contact. The resulting analogous structure is referred to as a corona oxide semiconductor (COS) system.
- A vibrating Kelvin probe provides capacitively-coupled sensing of the wafer surface potential. The probe acts as a non-intrusive voltmeter with virtually infinite input impedance.
- A pulsed light source linked to the Kelvin probe enables the stimulus and detection of surface photovoltage (SPV), providing measurement of band bending and $V_{fb}$.

# Benefits of COS Testing

With traditional C-V testing, test contacts must be applied in a metallization step or a polysilicon deposition process. These extra steps cause the testing cycle to take from one shift to two days to complete. In addition to increasing the processing time, these processes erase static charge *fingerprints*. These fingerprints can often provide clues to processing problems. Further, there is always the possibility that the additional steps are causing the problems being detected.

COS testing does not require any physical contact with the surface of the wafer. Since there is no physical contact or prior processing steps, the static charge fingerprint can be measured by mapping out the surface potential on the wafer. Because COS testing does not require metallization, information is obtained in minutes and the processing time and costs associated with metallization are eliminated. COS testing also allows the characterizing of individual processing steps because a preprocessed wafer can be measured, the step executed, and the same wafer measured again.

When Quantox tests are complete, the ionized corona layer can be neutralized by ordinary cleaning methods including rinsing the wafer in deionized water. Monitor wafers that have been run through the Quantox system can be reused with minimal costs for wafer rework. As a result of the time savings, a higher equipment usage rate is achieved.

# Corona Non-Contact Biasing

A corona source is simply a device for ionizing air molecules much like the ionizer in a clean room ventilation system. Quantox uses a similar system to spread a layer of ionized molecules across a wafer's surface to provide an electrical bias. The ionized molecules take the place of the metal dot structures used in C-V testing.

The corona source biases an oxidized wafer from accumulation to inversion in regular steps. There are three corona sources in the Quantox system. As shown in Figure A-2, the sources use a needle connected to a high voltage source to ionize existing room air and create a uniform flow of ionized air ions. Additional electrodes, or masks, are used to focus the flow of molecules toward the wafer surface. Because the process takes place in normal atmosphere, the ions have very low kinetic energy and adhere to the wafer surface without penetrating or causing damage to the wafer. In Quantox operation, either a positive or negative corona is used to bias the wafer surface depending on the bulk doping type. The predominant corona ionic species used are $CO_3^-$ and $H_3O^+$ for negative and positive coronas. The ionized molecules adhere to the oxide surface throughout the test.

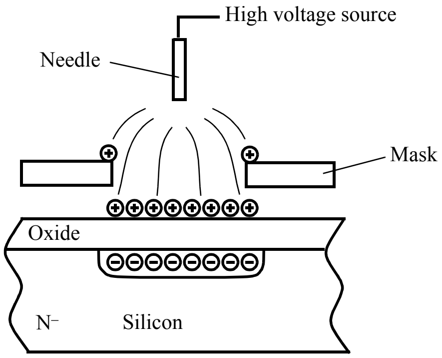


**Figure A-2**: Corona Biasing

Charge can be added or neutralized to change the bias applied while the electrical and optical properties are detected and recorded. After the measurements are obtained, corona ions of opposite polarity are used to bring the wafer back to its initial value. (Ionized molecules can also be removed by standard cleaning processes or a deionized water rinse.)

# Kelvin Probe Non-Contact Voltage Measurement

After the oxide has been biased, a Kelvin probe is used to measure the true surface potential of the oxide. This measurement is made without physical contact with the oxide.

Figure A-3 shows how a Kelvin probe operates. A small capacitor plate connected to the end of the probe is held approximately 0.1 mm (0.004 in.) above the oxide surface. The plate is mechanically oscillated, and a time-varying current is induced in the detection electronics. The oscillations make it possible to measure the true surface potential of the oxide with respect to a reference point such as bulk silicon. This measurement is made by capacitive coupling of the sensor to the wafer through an air gap.

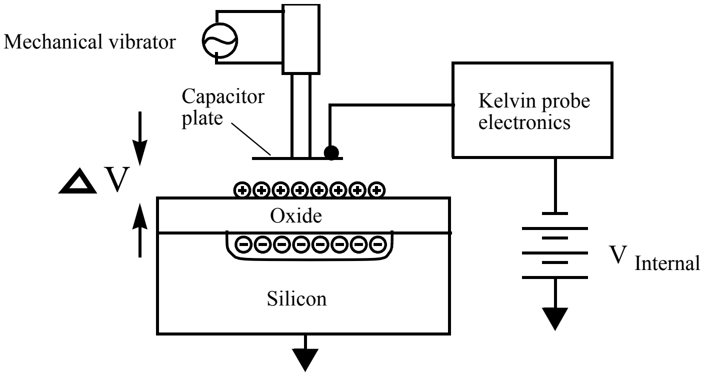


**Figure A-3**: Kelvin Probe

# SPV Measurements

SPV measurements obtain information about the electrical field near the surface of the silicon wafer. The basis of SPV is illustrated in Figure A-4. Photons emitted from the light source interact with the wafer. When photons with an energy greater than the silicon's bandgap fall upon the wafer, they penetrate to a certain depth depending upon the photon's energy level. The absorbed photons generate electron-hole pairs. If any field is present in the wafer due to band-bending, the electron-hole pairs are separated by the existing field and generate their own countering field. Normally this process takes place near the silicon surface, and the change in field results in a surface photovoltage.

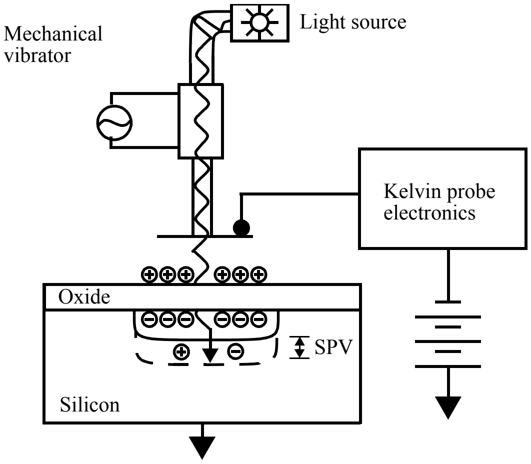


**Figure A-4**: SPV Measurement

SPV allows the Quantox system to measure the flat band voltage ($V_{fb}$) directly. When there is no SPV, there is no band-bending. So by definition, the measured voltage across the oxide when the SPV is zero is equal to the $V_{fb}$. Since any charge in the oxide produces band-bending and an SPV when illuminated, SPV can be used to monitor charge in the oxide.

# Appendix B
# System Administration

This Appendix includes the following procedures:

# Managing System Accounts

The username and password used to log on to the Quantox system determines the user's access to files on the system. User privileges are set by the System Administrator.

There are four user accounts available on the Quantox system:

- Administrator
- Engineer
- Operator
- Service

The Administrator account is used for system administration tasks and to load or upgrade the Quantox software package. The Engineer and Operator accounts give the user full access to all programs necessary to operate the system. The Service account is set up for field service and maintenance activities and should only be accessed by KLA-Tencor trained personnel.

**NOTE**

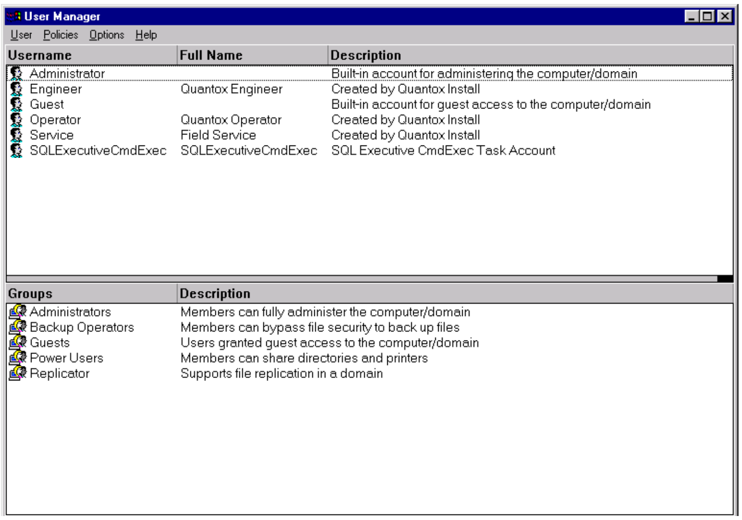
To create new account and groups, and to set permissions on files and directories, you must be logged in as Administrator.

## Creating a new account

To create a new account:

1. From the Windows NT Start Menu, select Programs | Administrative Tools | User Manager.

   The User Manager window opens (Figure B-1).



| Username | Full Name | Description |
|---|---|---|
| Administrator | | Built-in account for administering the computer/domain |
| Engineer | Quantox Engineer | Created by Quantox Install |
| Guest | | Built-in account for guest access to the computer/domain |
| Operator | Quantox Operator | Created by Quantox Install |
| Service | Field Service | Created by Quantox Install |
| SQLExecutiveCmdExec | SQLExecutiveCmdExec | SQL Executive CmdExec Task Account |

| Groups | Description |
|---|---|
| Administrators | Members can fully administer the computer/domain |
| Backup Operators | Members can bypass file security to back up files |
| Guests | Users granted guest access to the computer/domain |
| Power Users | Members can share directories and printers |
| Replicator | Supports file replication in a domain |

**Figure B-1**: User Manager Window

2. From the User menu, select New Local Group.

   The New Local Group dialog box opens (Figure B-2).

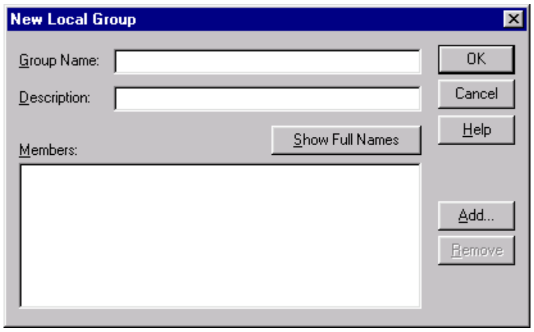


**Figure B-2**: New Local Group Dialog Box

3. Enter the desired Group Name and Description.

   To remove a member from the group, select the member and click Remove.

4. Click OK to save entries and return to the User Manager window.

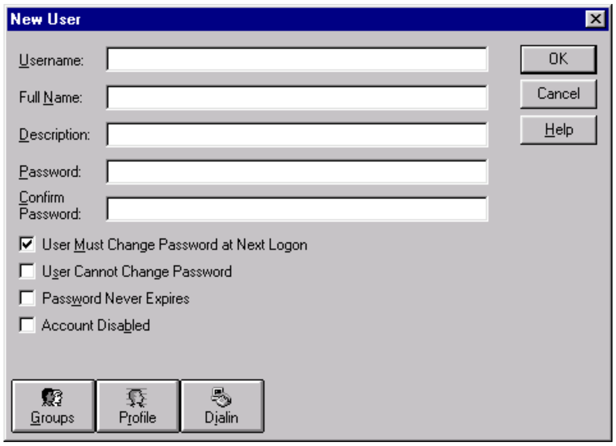
5. Exit the User Manager, or proceed to the next section to create a new user.

## Creating a new user

To create a new user:

1. If the User Manager window is not open, from the Windows NT Start Menu, select Administrative Tools | User Manager.
2. In the User menu, select New User.

   The New User dialog opens (Figure B-3).



☑ User Must Change Password at Next Logon
☐ User Cannot Change Password
☐ Password Never Expires
☐ Account Disabled

**Figure B-3**: New User Dialog Box

3. Fill in the Username, Full Name, Description, Password, and Confirm Password fields.
4. Check the User Cannot Change Password, and Password Never Expires boxes.
5. To add the new user to existing groups, click the Groups button.

   The Group Memberships dialog box opens (Figure B-4).

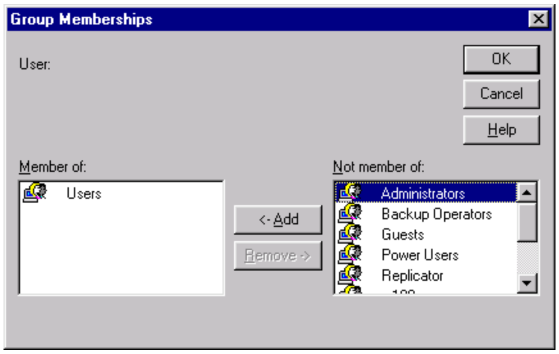


**Figure B-4**: Group Memberships Dialog Box

6. Select the desired group in the Not Member of: box and click Add.

   The selected group moves to the Member of: box.
7. Click OK to exit the Group Memberships dialog box.
8. Click OK to exit the New User dialog box.
9. Exit the User Manager.

---

# Enabling Changes to the POD Configuration (Automation Feature)

An NT Environment variable is used to control whether the Change POD Configuration dialog box is accessible in the each NT user account. To edit the Environment variable:

1. From the WindowsNT Start menu, select Start | Settings | Control Panel.
2. In the Control Panel, double-click the System icon.
3. Click the Environment tab.
   - If logged in with Administrator privileges, the System Variable can be edited. A System Variable applies to all users.
   - If ***not*** logged in with Administrator privileges, only the User Variable for the identified user can be edited.
4. In the Variable field, enter **`QoiShowPodConfig`**.
5. In the Value field, enter the **`TRUE`**.
6. Click Set.
7. Click OK.
8. Close the Control Panel.

# Setting Permissions on Files and Directories

Permissions can be set on entire directories, or on individual files within a directory. Quantox system Operators and Engineers need Full access privileges for the following files: SEIC.EXE, QDB.EXE, and Operator Interface.exe. Operators should only be given Full permission to these three files.

---

**CAUTION**

Restricting permission to Quantox directories, folders, or files can have a negative effect on the functionality of the tool. For example, restricting permission on a log file could crash the Quantox Operator Interface. Additionally, users must have write access to the directory that the database resides in.

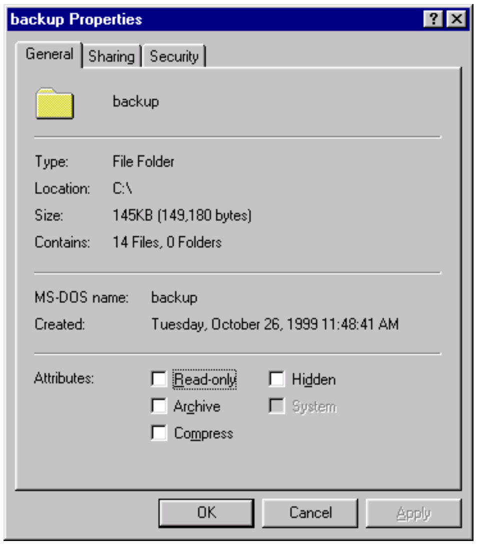
To avoid such problems, contact your KLA-Tencor Applications Engineer for advice on setting permissions.

---

To set permissions on directories and files:

1. From the Windows NT Explorer, select the file or directory to be protected.
2. Right-click the directory or file and select Properties.

   The General Properties page opens (Figure B-5). Options vary depending on whether a directory or file was selected. In this example, a directory was selected.



backup

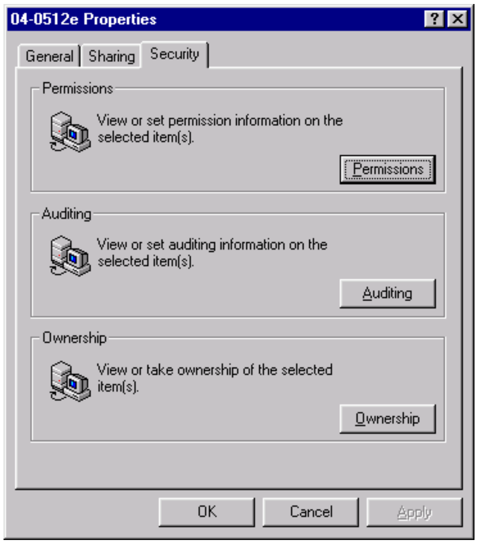
Type: File Folder
Location: C:\
Size: 145KB (149,180 bytes)
Contains: 14 Files, 0 Folders

MS-DOS name: backup
Created: Tuesday, October 26, 1999 11:48:41 AM

Attributes: ☐ Read-only ☐ Hidden ☐ Archive ☐ System ☐ Compress

**Figure B-5**: General Properties Page

3. Click the Security tab to access the Security page (Figure B-6).



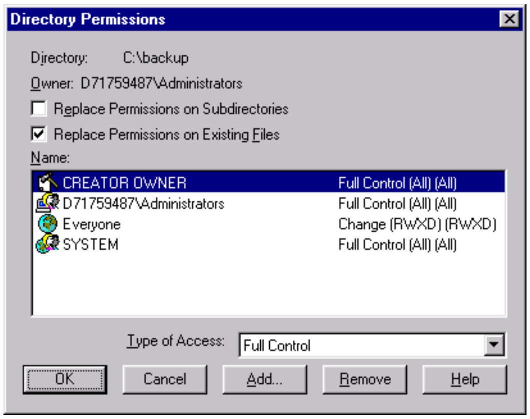
View or set permission information on the selected item(s).

View or set auditing information on the selected item(s).

View or take ownership of the selected item(s).

**Figure B-6**: Security Properties Page

4. Click the Permissions button to open the Permissions dialog box (Figure B-7). The display varies depending on whether a directory or file was selected in step 2.



Directory: C:\backup

Owner: D71759487\Administrators

☐ Replace Permissions on Subdirectories

☑ Replace Permissions on Existing Files

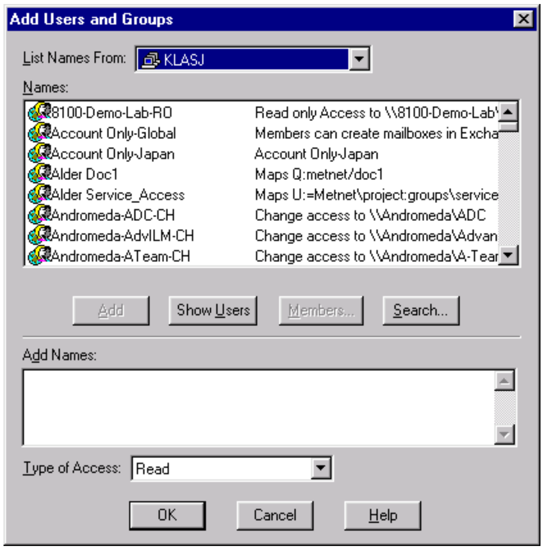
Name:

| | |
|---|---|
| CREATOR OWNER | Full Control (All) (All) |
| D71759487\Administrators | Full Control (All) (All) |
| Everyone | Change (RWXD) (RWXD) |
| SYSTEM | Full Control (All) (All) |

Type of Access: Full Control

**Figure B-7**: Directory Permissions Dialog Box

5. Click the Add button to open the Add Users and Groups dialog box (Figure B-8).



List Names From: KLASJ

Names:

| | |
|---|---|
| 8100-Demo-Lab-RO | Read only Access to \\8100-Demo-Lab\ |
| Account Only-Global | Members can create mailboxes in Excha |
| Account Only-Japan | Account Only-Japan |
| Alder Doc1 | Maps Q:metnet/doc1 |
| Alder Service_Access | Maps U:=Metnet\project:groups\service |
| Andromeda-ADC-CH | Change access to \\Andromeda\ADC |
| Andromeda-AdvILM-CH | Change access to \\Andromeda\Advan |
| Andromeda-ATeam-CH | Change access to \\Andromeda\A-Tear |

Type of Access: Read

**Figure B-8**: Add Users and Groups Dialog Box

6. In the List Names From: drop-down list, select the local computer, and click Add.

   The name should be “Q###”, where ### is the number of the Quantox system.

7. Select the name of the group having permissions set.

8. In the Type of Access drop-down list, select the type of access appropriate for the group.

   To enable complete access, select Full Control.

9. Click OK to close the dialog boxes.

# Setting Up a Printer

A printer can be installed in any Quantox system account, but the Administrator account should be used for setup. Depending on the files currently installed on the computer, this procedure might require the Windows NT CD-ROM and the printer's installation disk.

To set up the printer:

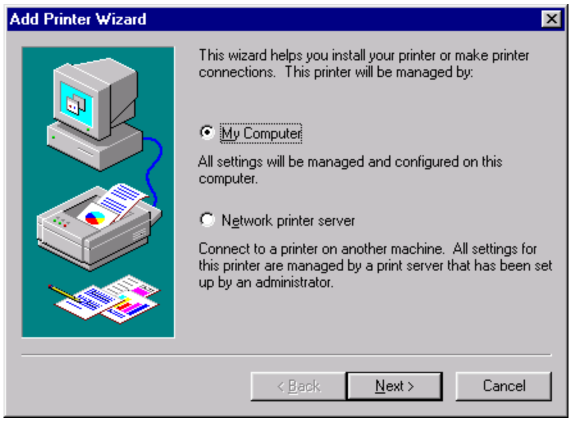
1. From the Windows NT Start menu, select Settings | Printers.
2. Double-click the Add Printer icon.

   The Add Printer Wizard opens (Figure B-9). The dialog box offers the option to add a local printer (My Computer) or a remote printer (Network printer server).

## Adding a Local Printer

To use a printer that is connected directly to a port on the system's computer:

1. Select the My Computer option, then click the Next button (Figure B-9).



This wizard helps you install your printer or make printer connections.  This printer will be managed by:

● My Computer

All settings will be managed and configured on this computer.

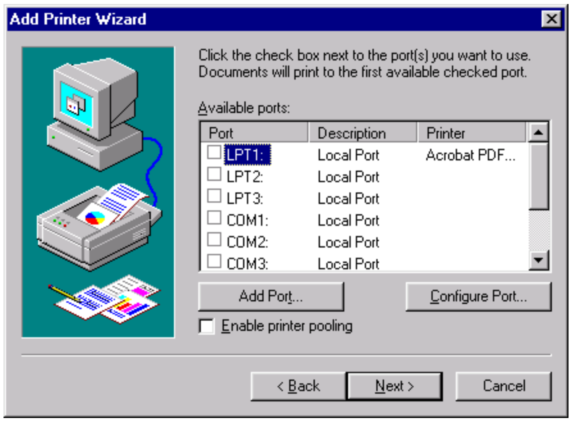
○ Network printer server

Connect to a printer on another machine.  All settings for this printer are managed by a print server that has been set up by an administrator.

**Figure B-9**: Adding a Printer

2. Click the printer port to be used (typically LPT1), then click Next (Figure B-10).

   Some printers have ports that allow them to be connected directly to the network instead of a computer. These are called network interface printers. When connecting directly to a network interface printer, a port must be added. Refer to the printer's documentation.



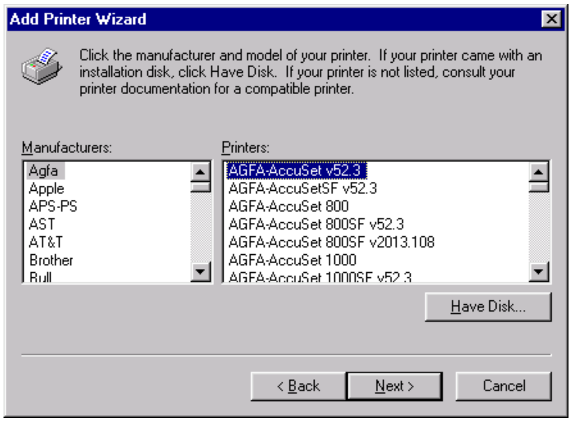
Click the check box next to the port(s) you want to use. Documents will print to the first available checked port.

| Port | Description | Printer |
|---|---|---|
| ☐ LPT1: | Local Port | Acrobat PDF... |
| ☐ LPT2: | Local Port | |
| ☐ LPT3: | Local Port | |
| ☐ COM1: | Local Port | |
| ☐ COM2: | Local Port | |
| ☐ COM3: | Local Port | |

☐ Enable printer pooling

**Figure B-10**: Selecting a Port

3. Click the name of the printer manufacturer and model. Read and follow any other instructions displayed in the dialog box (Figure B-11).



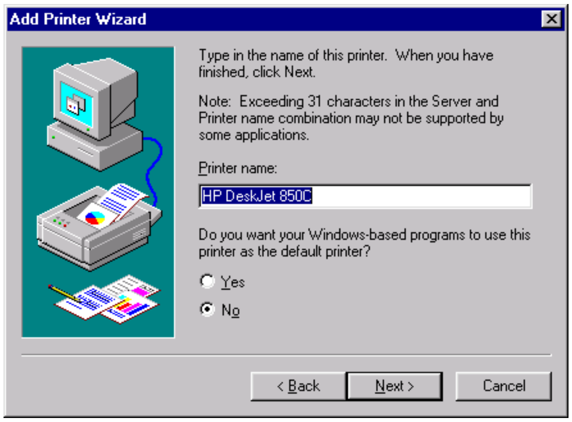
Click the manufacturer and model of your printer. If your printer came with an installation disk, click Have Disk. If your printer is not listed, consult your printer documentation for a compatible printer.

Manufacturers:
- Agfa
- Apple
- APS-PS
- AST
- AT&T
- Brother
- Bull

Printers:
- AGFA-AccuSet v52.3
- AGFA-AccuSetSF v52.3
- AGFA-AccuSet 800
- AGFA-AccuSet 800SF v52.3
- AGFA-AccuSet 800SF v2013.108
- AGFA-AccuSet 1000
- AGFA-AccuSet 1000SF v52.3

**Figure B-11**: Selecting a Printer

4. Click Next.
5. In the Printer name field, enter an identifying name for the printer (Figure B-12). To select this printer as the default printer, click Yes.



Type in the name of this printer. When you have finished, click Next.

Note: Exceeding 31 characters in the Server and Printer name combination may not be supported by some applications.

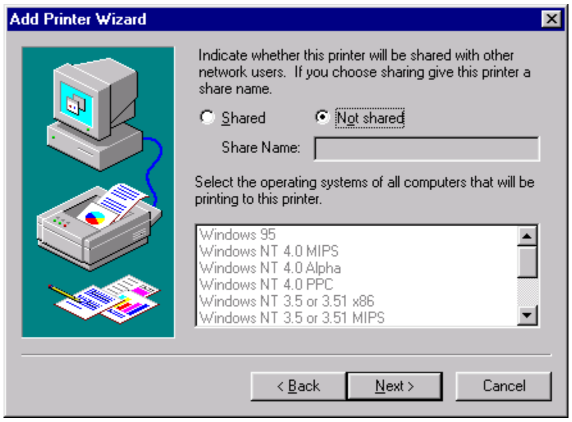
Printer name: HP DeskJet 850C

Do you want your Windows-based programs to use this printer as the default printer?

○ Yes
● No

**Figure B-12**: Naming the Printer

6. When the selection is complete, click Next.
7. Indicate if the printer will be shared over the network (Figure B-13).



Indicate whether this printer will be shared with other network users. If you choose sharing give this printer a share name.

○ Shared ● Not shared

Share Name:

Select the operating systems of all computers that will be printing to this printer.

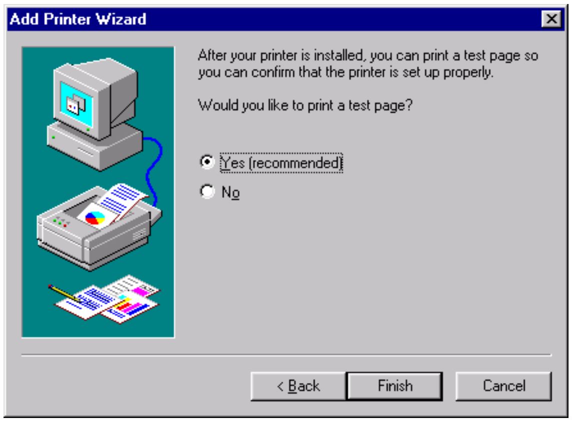
Windows 95
Windows NT 4.0 MIPS
Windows NT 4.0 Alpha
Windows NT 4.0 PPC
Windows NT 3.5 or 3.51 x86
Windows NT 3.5 or 3.51 MIPS

**Figure B-13**: Sharing the Printer

8. If the printer will be shared over the network:
   - Enter a Share Name. The Share Name enables networked users to identify the printer.
   - Indicate all operating systems that will be used to access the printer.
9. Click Next.
10. Indicate if the system should print a test page (Figure B-14).

11. Click Finish to complete the installation.

    If the system cannot locate the files needed to set up the printer, it displays a message asking for the path to the required files. Follow the instructions that appear onscreen.



After your printer is installed, you can print a test page so you can confirm that the printer is set up properly.

Would you like to print a test page?

● Yes (recommended)

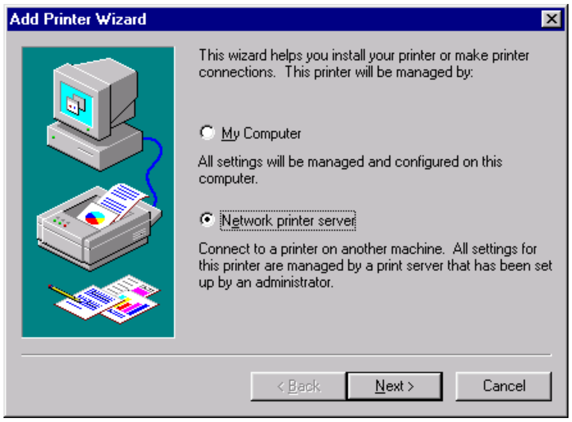
○ No

**Figure B-14**: Completing the Printer Installation

## Adding a Remote Printer

To use a remote printer:

1. Select the Network printer server option and click Next (Figure B-15).



This wizard helps you install your printer or make printer connections. This printer will be managed by:

○ My Computer

All settings will be managed and configured on this computer.

● Network printer server

Connect to a printer on another machine. All settings for this printer are managed by a print server that has been set up by an administrator.

**Figure B-15**: Adding a Network Printer

2. In the Connect to Printer dialog box (Figure B-16), select the desired printer by clicking it, then click OK.

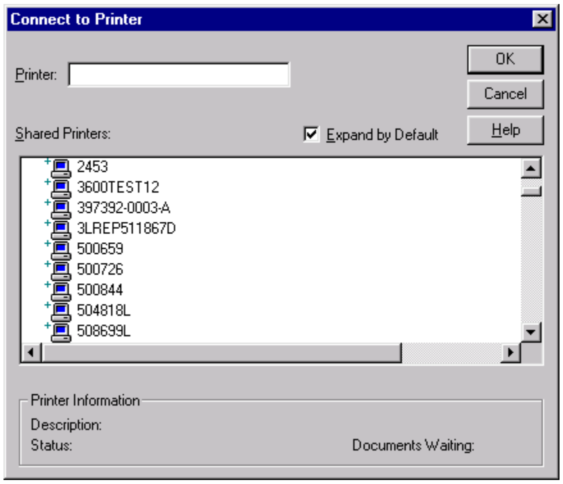


**Figure B-16**: Connect to Printer Dialog Box

3. Indicate if the printer should be the default printer, and click Next.
4. Click Finish.

## Changing Printer Settings

To change a printer’s settings:

1. From the Windows NT Start menu, select Settings | Printers.
2. Right-click the printer, and select the desired option (Figure B-17):

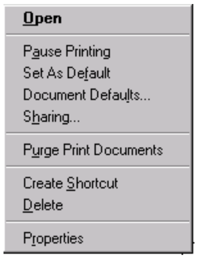


**Figure B-17**: Printer Shortcut Menu

# Setting Up a Network

Network connections for the Quantox system should be set up by the network administrator for the site. The network setup for each Quantox system is site specific and not a standard KLA-Tencor support option. A T1-based connection on the back of the Quantox computer can be used to connect to a network. When the system computer is connected to the network, the Quantox files can be accessed by other computers on the network. Quantox offline software, installed on a networked computer, can be used to interface with Quantox applications such as Recipe Builder and Report Generator.

# Managing the Quantox Databases

The database in Quantox software versions 3.2 and later use a connection mechanism called Data Access Objects (DAO) which allows for completely dynamic and independent database access (reads and writes). All database-oriented applications provided for versions 3.2 and 3.3 support this new generic access mode, such that the user need only select the database file from within the application.

Quantox Database connectivity in software versions prior to version 3.2 (200-mm systems) were based on Open Database Connectivity (ODBC) connections. This connection scheme used the ODBC Data Source Name concept for database independence. The restriction of this technique is that there is no dynamic way to access multiple databases for a specific user.

To support data access from software versions 3.1 and earlier, software versions 3.2 and later include the ODBC-oriented Report Generator, Data Wizard, and Subtraction Report components. In order to utilize these components, ODBC must be configured, and the version-specific utilities must be configured and accessed as described on the following pages.

## Data Access for version 3.1 Databases

As mentioned above, Quantox software versions 3.1 and earlier use Microsoft ODBC as the data transport mechanism. In order to access data collected with version 3.1 or earlier, ODBC must be properly configured.

**NOTE**

ODBC need only be configured if the system will be used to access data collected under software versions 3.1 and earlier.

### Configuring a New ODBC Pointer

You must be logged in as Administrator to configure a new ODBC pointer.

To configure an ODBC pointer:

1. From the Windows NT Start menu, select Settings | Control Panel.
2. In the Control Panel (Figure B-18), double-click the ODBC icon.

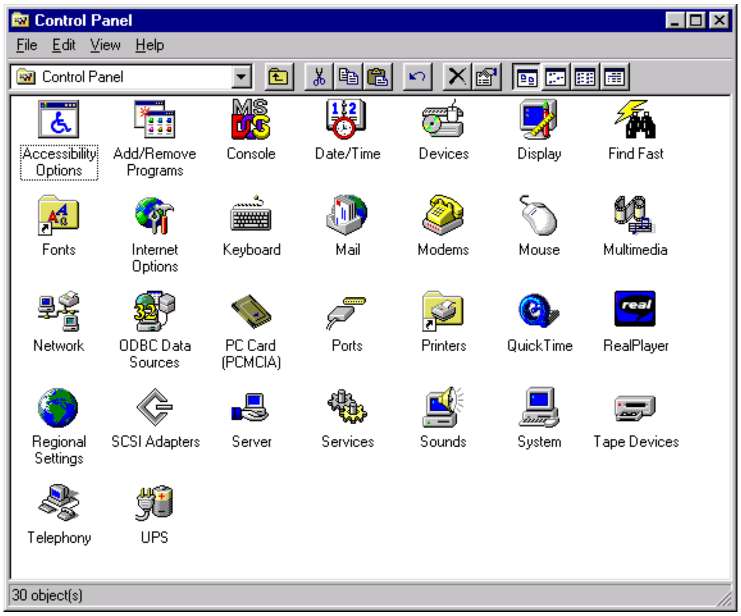
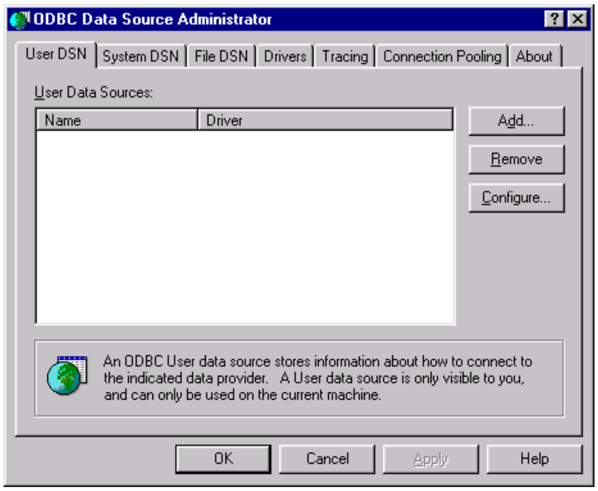


**Figure B-18**: Control Panel

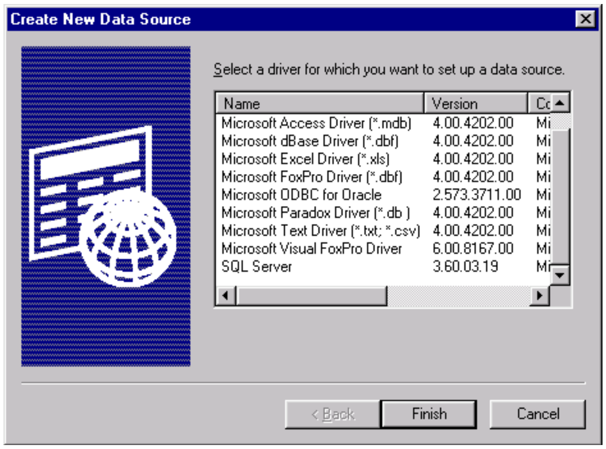
3. In the ODBC Data Source Administrator window (Figure B-19), click the Add button.



An ODBC User data source stores information about how to connect to the indicated data provider. A User data source is only visible to you, and can only be used on the current machine.

**Figure B-19**: ODBC Data Source Administrator Window

4. In the Create New Data Source dialog box (Figure B-20), select the Microsoft Access Driver and click Finish.



| Name | Version | Cc |
|---|---|---|
| Microsoft Access Driver (*.mdb) | 4.00.4202.00 | Mi |
| Microsoft dBase Driver (*.dbf) | 4.00.4202.00 | Mi |
| Microsoft Excel Driver (*.xls) | 4.00.4202.00 | Mi |
| Microsoft FoxPro Driver (*.dbf) | 4.00.4202.00 | Mi |
| Microsoft ODBC for Oracle | 2.573.3711.00 | Mi |
| Microsoft Paradox Driver (*.db ) | 4.00.4202.00 | Mi |
| Microsoft Text Driver (*.txt; *.csv) | 4.00.4202.00 | Mi |
| Microsoft Visual FoxPro Driver | 6.00.8167.00 | Mi |
| SQL Server | 3.60.03.19 | Mi |

**Figure B-20**: Create New Data Source Dialog Box

5. In the ODBC Microsoft Access Setup dialog box (Figure B-21), type QUANTOX DB (uppercase letters, single space between QUANTOX and DB) in the Data Source Name field, and click the Select button.

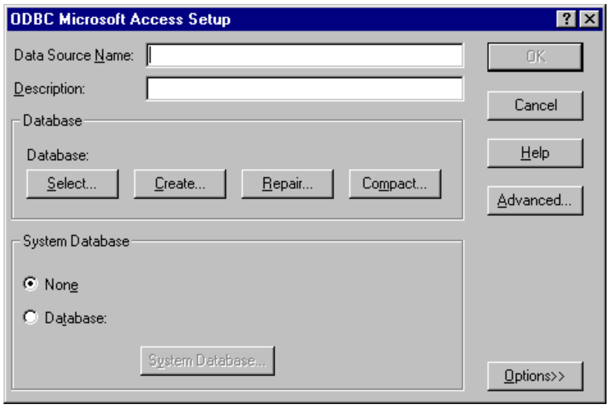
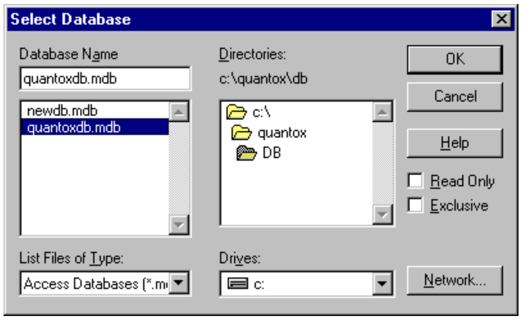


**Figure B-21**: ODBC Microsoft Access Dialog Box

6. In the Select Database dialog box (Figure B-22) locate the database file (*.mdb) to be used, click the file, and then click OK.



Database Name: quantoxdb.mdb

newdb.mdb
quantoxdb.mdb

Directories: c:\quantox\db

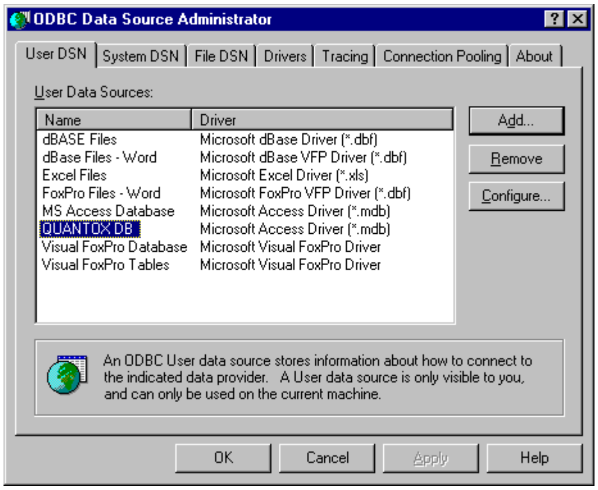
c:\
quantox
DB

List Files of Type: Access Databases (*.m

Drives: c:

**Figure B-22**: Select Database Dialog Box

The ODBC Data Source Administrator window now lists QUANTOX DB and Microsoft Access Driver (*.mdb) as shown in Figure B-23.



User Data Sources:

| Name | Driver |
|---|---|
| dBASE Files | Microsoft dBase Driver (*.dbf) |
| dBase Files - Word | Microsoft dBase VFP Driver (*.dbf) |
| Excel Files | Microsoft Excel Driver (*.xls) |
| FoxPro Files - Word | Microsoft FoxPro VFP Driver (*.dbf) |
| MS Access Database | Microsoft Access Driver (*.mdb) |
| QUANTOX DB | Microsoft Access Driver (*.mdb) |
| Visual FoxPro Database | Microsoft Visual FoxPro Driver |
| Visual FoxPro Tables | Microsoft Visual FoxPro Driver |

An ODBC User data source stores information about how to connect to the indicated data provider. A User data source is only visible to you, and can only be used on the current machine.

**Figure B-23**: ODBC Data Source Administrator Window

7. Click OK.

   The ODBC pointer is now configured to the selected database.

### Changing the ODBC Pointer

Changing an ODBC pointer allows a user to read and write data to a different database. Individual users can change an ODBC pointer without being logged in as Administrator.

To change the ODBC pointer:

1. Make sure the Quantox Database application (QDB) and Report Generator are not running.
2. From the Windows NT Start menu, select Settings | Control Panel.
3. In the Control Panel, double-click the ODBC icon (Figure B-24).

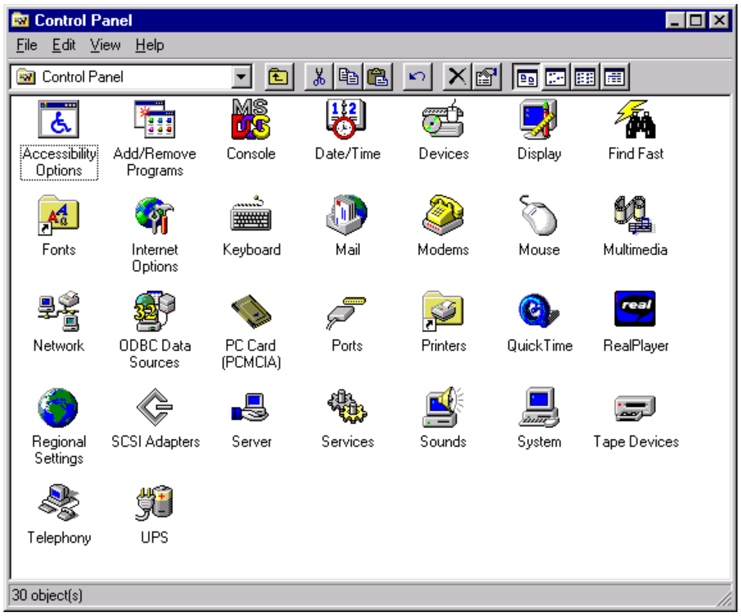
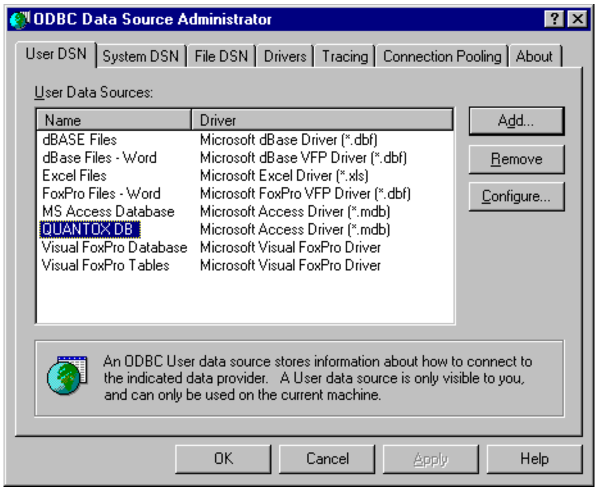


**Figure B-24**: Control Panel

4. In the ODBC Data Source Administrator window, select the QUANTOX DB and click Configure (Figure B-25).



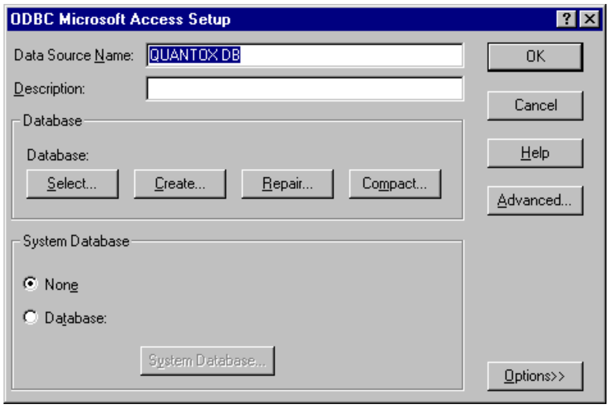
User Data Sources:

| Name | Driver |
|---|---|
| dBASE Files | Microsoft dBase Driver (*.dbf) |
| dBase Files - Word | Microsoft dBase VFP Driver (*.dbf) |
| Excel Files | Microsoft Excel Driver (*.xls) |
| FoxPro Files - Word | Microsoft FoxPro VFP Driver (*.dbf) |
| MS Access Database | Microsoft Access Driver (*.mdb) |
| QUANTOX DB | Microsoft Access Driver (*.mdb) |
| Visual FoxPro Database | Microsoft Visual FoxPro Driver |
| Visual FoxPro Tables | Microsoft Visual FoxPro Driver |

An ODBC User data source stores information about how to connect to the indicated data provider. A User data source is only visible to you, and can only be used on the current machine.

**Figure B-25**: ODBC Data Source Administrator Window

5. In the ODBC Microsoft Access Setup dialog box, click the Select button (Figure B-26).



Data Source Name: QUANTOX DB

Description:

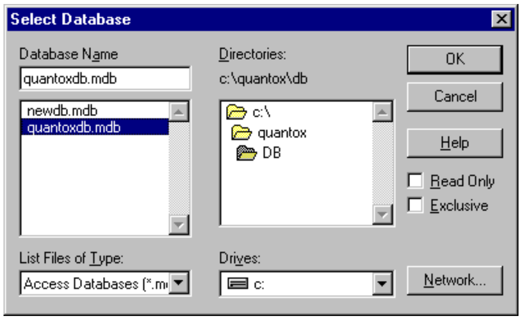
Database:

● None

○ Database:

**Figure B-26**: ODBC Microsoft Access Setup Dialog Box

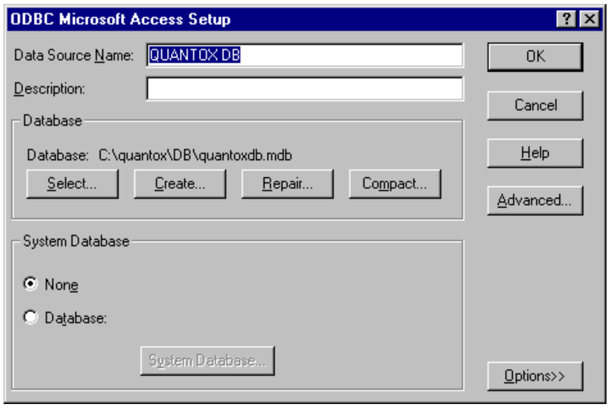
6. In the Select Database dialog box, locate the database file (*.mdb) to be used (Figure B-27).
7. Click the file, and then click OK.



Database Name: quantoxdb.mdb
newdb.mdb
quantoxdb.mdb
Directories: c:\quantox\db
☐ Read Only
☐ Exclusive
List Files of Type: Access Databases (*.m
Drives: c:

**Figure B-27**: Select Database Dialog Box

8. The ODBC Microsoft Access Setup dialog box opens with the new database pointer indicated in the Database section (Figure B-28). Click OK.



Data Source Name: QUANTOX DB
Description:
Database
Database: C:\quantox\DB\quantoxdb.mdb
System Database
● None
○ Database:

**Figure B-28**: ODBC Microsoft Access Setup Dialog Box

9. The display returns to the Data Sources Administrator window. Click OK.
10. Close the Control Panel.

### Data Wizard Access

Both the DAO and ODBC-oriented versions of Data Wizard are incorporated into the standard Quantox Data Wizard. The appropriate version of Data Wizard is launched in Excel by choosing it from a Quantox menu. Refer to Chapter 6 for details.

### Report Generator Access

Both the DAO and ODBC-oriented versions of the Report Generator are provided with the standard Quantox system software and the Quantox Offline software. In order to access the ODBC-oriented version (for data collected with versions prior to 3.2), you must first run ReportGenerator_ODBC.Exe.

To run the program:

1. From the Windows NT Start menu, select Run.
2. Key in C:\Quantox\Bin\ReportGenerator_ODBC.Exe, and click OK.

### Subtraction Report Access

The Subtraction Report is a plug-in to the Report Generator. The version-specific plug-in must be properly registered before the Report Generator can launch it. This is accomplished by executing the appropriate batch file in the C:\Quantox\Bin directory.

To use the Subtraction Report for versions prior to 3.2:

1. From the Windows NT Start menu, select Run.
2. Key in C:\Quantox\Bin\RegisterSubtractionReportODBC.Bat, and click OK.

To use the Subtraction Report for version 3.2 or later:

1. From the Windows NT Start menu, select Run.
2. Key in C:\Quantox\Bin\RegisterSubtractionReport.Bat, and click OK.

After running the appropriate file, launch ReportGenerator and select Tools | Subtraction Report.

## Data Access for Version 3.2 and later Databases

In software version 3.2 and later, the database is created dynamically. If a database is specified but it does not yet exist, the database logging application automatically creates the specified database and logs the test results to that database.

### Creating a Database

The simplest way to create a new database is to specify a new database name in the Recipe Builder. The database logging application creates the database on the first data logging request to that database.

### Archiving a Database

Archiving a database can be as easy as renaming the database. The Quantox system then dynamically creates a new database, as it is needed.

# Backing Up Files to the Conner Tape Drive

KLA-Tencor recommends that a tape backup be done at least every three months to ensure that the Quantox configuration and data are maintained in case a serious computer malfunction occurs.

**NOTE**

Information stored between the time of the most recent backup and the time of a hard drive failure is likely to be lost. Therefore, you might wish to perform system backup frequently.

All the files in the following directories should be backed up:

- C:\Quantox\DB\
- C:\Quantox\Recipes\
- C:\Quantox\Dat\
- C:\Quantox\Bin\Config\
- C:\Quantox\Scripts\

The following procedure is for systems equipped with a Conner tape drive and running Window NT 4.0. The procedure assumes that the database is on the C: drive. The tape used is a Travan TR-3 minicartridge 400 MB tape. This procedure should be performed when the Quantox is idle. The backup can take several minutes to complete.

To back-up a file:

1. Insert the tape into the Quantox tape drive, located behind the system’s front panel in the Quantox computer.
2. Log in as Administrator.
3. From the Windows NT Start menu, select Programs | Administrative Tools | Backup.
4. Double-click the Drives icon.
5. In the drives window, double-click the gray drive icon labeled C: (Figure B-29).

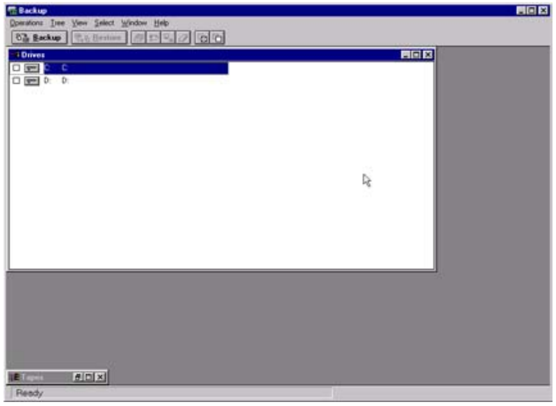


**Figure B-29**: Drives Window

6. In the directory list, double-click the yellow folders to locate, for example, C:\Quantox\DB\QuantDB.mdb (Figure B-30).

7. Click the check box next to the file to be backed up. This is the only file that will be backed up now.

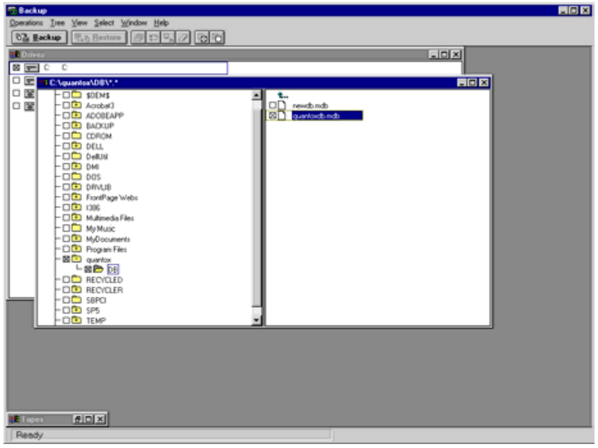


**Figure B-30**: Directory List

8. Click the Backup button in the upper left-hand corner of the window.

9. Review the backup information, then click OK.

   It takes several minutes for the tape to rewind and then copy the database. At the end of the procedure, the software displays the message "The operation was successfully completed."

10. Review the information displayed, and click OK.

11. Repeat this procedure to back up additional files as necessary.

# Appendix C
# SECS/GEM Interface

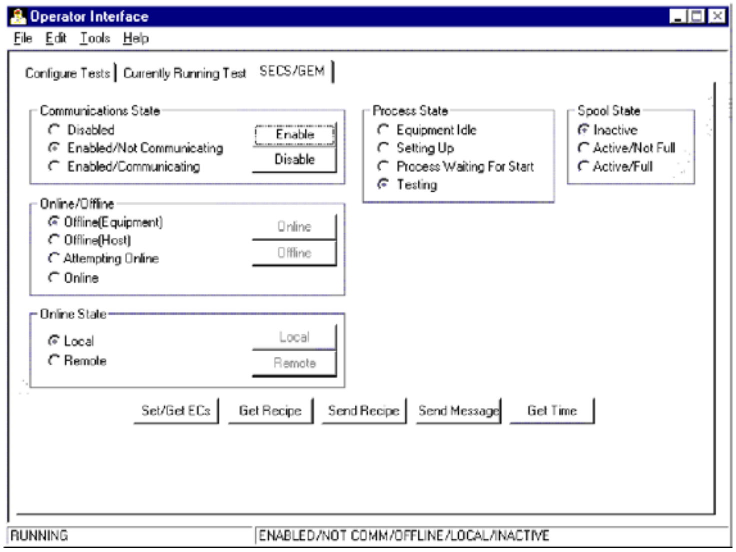
SECS/GEM Interface is an optional software package that allows Quantox to be integrated into a fab automation network and controlled by a remote host computer.

The physical connection is achieved through a SECS I (RS-232) serial port at the back of the Quantox machine. Communications between Quantox and the host controller complies with the Generic Equipment Model (GEM) as described in the SEMI E30-95 Standard document. The GEM standard specifies standardized methods of using the Semiconductor Equipment Communications Standard (SECS) II messages to accomplish tasks common to most semiconductor manufacturing equipment.

For specific information on the GEM standard implementation, refer to *Quantox GEM Interface Operations/Specifications*, (64000-906-01 F) and *Quantox GEM and SECS-II Supplement for Software Version 3.2* (04-0500 A).

## SECS/GEM Page

With the SECS/GEM Interface installed, click the SECS/GEM tab in the Operator Interface to display the SECS/GEM page (Figure C-1).



Communications State
○ Disabled
● Enabled/Not Communicating
○ Enabled/Communicating

Online/Offline
● Offline(Equipment)
○ Offline(Host)
○ Attempting Online
○ Online

Online State
● Local
○ Remote

Process State
○ Equipment Idle
○ Setting Up
○ Process Waiting For Start
● Testing

Spool State
● Inactive
○ Active/Not Full
○ Active/Full

RUNNING
ENABLED/NOT COMM/OFFLINE/LOCAL/INACTIVE

**Figure C-1**: SECS/GEM interface main screen

The SECS/GEM page is divided into five sections:

- Communications State
- Online/Offline
- Online State
- Process State
- Spool State

The page also provides a group of five control buttons. Refer to the following sections for details.

# Communications State

The Communications State displays the current SECS II communications state of the Quantox system. There are three possible communications states:

- Disabled: all SECS communication is disabled at the Quantox system. The system does not send any messages to the host, and it does not respond to any messages sent from the host.
- Enabled/Not Communicating: SECS communications is possible but has not yet been successfully established.
- Enabled/Communicating: the SECS link between the host and the Quantox system has been established.

An operator may enable or disable SECS communication by clicking the Enable or Disable button.

# Online/Offline

When SECS communications is enabled, the Online/Offline state shows one of the four possible control states:

- Offline (Equipment): the Quantox system is controllable from the Operator Interface only. An operator must click on the Online button to take the Quantox on-line.
- Offline (Host): the Quantox system is ready to go on-line but is waiting for a request from the host.
- Attempting Online: the Quantox system is attempting to change from off-line to on-line by requesting permission from the host.

- Online: the SECS link between the host and the Quantox system operates with no or few restrictions.

An operator may bring the Quantox on-line or off-line by clicking on the Online or Offline button.

# Online State

When the Quantox system is on-line, the Online State shows one of the two possible sub-states:

- Local: the operator has control over the Quantox system via the Operator Interface. The system rejects remote commands from the host. However, the host has access to all system variables and receives all collection events.
- Remote: the host has control over the Quantox system via remote commands. If the operator attempts to issue local commands via the Operator Interface, the host is notified. The locally issued command is not executed.

An operator may bring the Quantox system to local or remote sub-state by clicking on the appropriate Local or Remote button.

# Spool State

The Spool State shows one of the three possible spooling states:

- Inactive: under normal conditions, the Quantox system stays in this state. SECS communications takes place normally. The spool is empty and no messages are added to the spool.
- Active/Not Full: the Quantox enters this state whenever it has detected a communications failure. All primary messages for which spooling is enabled by the host are directed to the spooling system. Once this state is entered, the host must unload or purge the spool to restore normal operation.
- Active/Full: the spool file is full. Any message sent for spooling is either discarded or written to the spool file (replacing the oldest message in the spool) depending on how the Quantox system is configured.

# Process State

The Process State shows one of the four possible processing states:

- Equipment Idle: the Quantox system is not testing and is not set up to start a test.
- Setting Up: the Quantox system has received at least one of several commands necessary to set up for a test. More information or actions are required to complete the setup before testing can begin.
- Process Waiting For Start: the Quantox system has received all required information and actions needed to start testing.
- Testing: the Quantox system is running tests.

# Control buttons

The control buttons at the bottom of the SECS/GEM page include

- Set/Get ECs: enables the operator to set or query the value of a GEM equipment constant.
- Get Recipe: enables the operator to enter a recipe name to be downloaded from the host.
- Send Recipe: enables the operator to enter a recipe name to be uploaded to the host.
- Send Message: enables the operator to enter a text message to be sent to the host.
- Get Time: synchronizes the Quantox SECS/GEM interface time-base to the host time.

# Appendix D
# GLOSSARY

## Quantox User Glossary of Symbols and Abbreviations

| Symbol or Abbreviation | Definition |
|---|---|
| A | area |
| ADO | ActiveX Data Objects (a Microsoft feature) |
| BR Lifetime | Bulk Recombination Lifetime |
| BTS | bias temperature stress |
| C | capacitance |
| CG | Corona Gun |
| CO | Corona |
| COKP | Corona Kelvin Prove |
| $C_{ox}$ | oxide capacitance |
| $D_{it}$ | interface-trapped charge density |
| DAC | digital-to-analog converter |
| DAO | Data Access Objects (a Microsoft feature) |
| DB Admin | Database Administration |
| DB Converter | Database Converter |
| $\Sigma$ | dielectric constant |
| EMID | Equipment Material ID |
| $\Sigma_{ox}$ | oxide dielectric constant |

| Symbol or Abbreviation | Definition |
|---|---|
| $\Sigma_{si}$ | silicon dielectric constant |
| FFU | Fan Filter Unit |
| G Lifetime | Generation Lifetime |
| J | current density |
| JV | current density–voltage |
| KP | Kelvin Probe |
| Map Plan | tests a defined area of a wafer |
| MDAC | Microsoft Data Access Components |
| N type silicon | doped with donor impurities |
| ODBC | Open Database Connectivity (a Microsoft feature) |
| P type silicon | doped with acceptor impurities |
| Q | charge |
| QDB | Quantox Database |
| QDW | Quantox Data Wizard |
| $Q_{eff}$ | effective charge |
| $Q_{it}$ | interface-trapped charge |
| $Q_m$ | mobile charge |
| $Q_{net}$ | net oxide charge |
| QOI | Quantox Operator Interface |
| QRB | Quantox Recipe Builder |
| QRG | Quantox Report Generator |
| $Q_{surf}$ | surface charge |

| Symbol or Abbreviation | Definition |
|---|---|
| $Q_{tot}$ | total charge |
| Site Plan | tests on specific sites of a wafer |
| SR Lifetime | Recombination Lifetime |
| SPV | Surface Photo Voltage |
| T | thickness |
| $T_{ox}$ | oxide thickness |
| V | voltage |
| $V_{fb}$ | flatband voltage |
| $V_{mid}$ | midband voltage |
| $V_{ox}$ | oxide voltage |
| $V_s$ | surface voltage |
| $V_{sbd}$ | soft breakdown voltage |
| W | depth |
| WCU | Wafer Conditioning Unit |
| $W_{dd}$ | deep-depletion depth |

# Index