Nanometrics

NanoSpec 3000 Series

Automated Film Thickness Measurement System

Users Manual

Part Number: 7500-1105 P1

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About This Manual

This manual provides the information you need to operate and program the NanoSpec® 3000, to be known from here on as Model 3000, Automated Film Thickness (AFT) Measurement System. If some points are unclear while operating the software, refer to the On-line Help.

NOTICE

The NanoSpec 3000 software and microscope stack is used in many older instrument derivative upgrades. This manual also applies to these upgrades that uses the M3000 software and optical head.

How To Use This Manual

This manual covers procedures for the Model 3000 in the Production Mode and Process Engineer Mode (referred to in this manual as the Operations Mode and Engineering Mode, respectively). These procedures are divided into four parts under which are further divided into sections. System operators are responsible for Part 1 and Part 2. System engineers are responsible for all parts of the Manual.

Part 1: Perusing the Model 3000 Features consists of the following:

This section is a general overview of the Model 3000, its capabilities, system components, and controls and indicators. The section covers precautions, pre-operation procedures, power-up and initialization procedures, and power-down procedures.

Part 2: Learning the Model 3000 Process Basics consists of the following:

This section explains everything operators need to know to operate the Model 3000: logging on and off; selecting measurement programs; taking reference scans; taking measurements of the sample wafers; and displaying and printing raw measurement lists and interferograms of these measurements.

Part 3: Mastering the Model 3000 Features consists of the following:

This section contains information that is important to process engineers who must design custom measurement programs. This section explains everything engineers need to program the Model 3000.

Part 4: Model 3000 Maintenance consists of the following:

This section contains information that is important to engineers in maintaining the instrument in peak operating condition.

Who Should Use This Manual

...for Operation　The operation of the Model 3000 is intended for production personnel, process engineers, and Nanometrics trained service personnel.

Production personnel should read Part 1 and Part 2 and then, if necessary, Part 4 to check on the details of individual programs.

Process engineers and service engineers should read Part 1 through Part 4 to become thoroughly familiar with the instrument.

...for Maintenance　The Model 3000 is a very complex electro-mechanical device consisting of a precision microspectrophotometer system. Because of the machine's complexity, it should be installed and serviced only by either service engineers from Nanometrics or others who have completed Nanometrics service training classes. These training classes provide a thorough understanding of the operation of the machine and instructs personnel on the use of the system's support tools.

For information about training, contact the Nanometrics Customer Support at (800) 955-6266 or (408) 746-1600.

Additional Sources of Information

For any additional questions on installation and maintenance, you may contact Nanometrics Customer Support at (800) 955-6266 or (408) 746-1600.

Consult your local library or bookstore for books on concepts in microscopy and spectroscopy.

Manual Conventions

This manual uses the following typographic conventions:

Keyboard Conventions

Key Cap Names The names of key caps on the computer keyboard are spelled out and appears bold in angle brackets. Some example key caps are shown as:

<Esc>, **<Enter>**, **<F1>**, **<Ctrl>**

Key Combinations A plus sign between two or more key names means that you must hold down the first key while pressing the next key. For example, the instruction:

Press **<Ctrl>** + **<F10>**

means "Press the **<Ctrl>** key and while holding it down, press the **<F10>** key." As soon as you have completed these steps, you can release all keys.

What You Type Commands or responses to prompts that you should type as indicated in the instructions are shown in quotes. For example, you type:

y

in response to the instruction, Type "y" in response to the prompt.

All screen buttons (which you click on with your mouse) appears bold. Some screen buttons examples are shown as:

Cancel, **Enter**, **Exit**

Trackball Assembly Functions

The trackball assembly consists of a ball, which is rolled to move the cursor on the screen, and a left and right button, which are used to access screens and windows and activate commands.

Left Button The left button is used for the following:

- Selecting a film program or lens in either the Operations Mode or the Engineering Mode. If you click once with the left button, the window appears, requiring you to click on the ENTER command button to load your selection into the program.

  When you double-click (rapidly) you can enter the film-type or lens-type window without having to click on the ENTER command button.

- most engineering and service maintenance functions, which are activated with a single click.

- accessing the database in the Engineering Mode, which is activated by a single click *only.*

Please be patient after clicking once, as it takes up to 15 seconds to load all the files from the database before a screen prompt appears.

Right Button The right button is used for the following:

- when you are at the most detailed level of the screen displaying the database in the Engineering Mode.

  With a single click of the right button, a pop-up menu appears on this screen. This menu gives you the choice of all the menu options at the top of the screen when the left button is already engaged in selecting (highlighting) multiple measurements.

- when the cursor is in the *User ID* field of the *Logon* window. A single click of the right button shuts down the system.

Screen Conventions

- Names given to unlabeled screens or windows for convenience of reference are capitalized and appear in quotes, such as "GRAPH DISPLAY SCREEN".

- Program names not displayed as the name of a window, screen, field, or menu option are initial capitalized, such as the Engineering Mode or Operations Mode.

- Screen prompts or messages (which are not part of the above-mentioned screens or windows) are shown bold and in quotes. An example is:

  "Measuring..."

Terminology

In this manual, the following terms are defined below.

Click The left side switch on the track ball, press and release quickly.

Double Click Two successive clicks in a short interval.

Drop-down Menu An appearing menu when clicking on a menu item.

Log-on Entering User ID and Password to enter the software program with operator or engineer privileges.

Log-off Removes the previous User ID and prepares for the next Log-on.

Federal Communications Commission Radio Frequency Interference Statement

This equipment generates and uses radio frequency energy. If not installed and used in strict accordance with the manufacturer's instructions, the equipment may cause interference with radio communications. It has been type tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case whatever measures required to correct the interference must be taken at the owner's expense. (FCC, Part 15.818a)

Instructions to User If this equipment does cause interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient the receiving antenna.
- Relocate the equipment with respect to the receiver.
- Move the equipment away from the receiver.
- Plug the equipment into an outlet that is on a different circuit branch than the receiver.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions.

The user may find the following booklet prepared by the Federal Communications Commission helpful: *How to Identify and Resolve Radio-TV Interference Problems.* This booklet is available from the U.S. Government Printing Office, Washington DC 20402. Stock No. 004-000-00345-4.

Perusing the Model 3000

The following topics are covered in this section:

Section 1
Introduction

The NanoSpec® 3000 Automated Film Thickness (AFT) Measurement System, hereafter referred to as the Model 3000 or M3000, is an instrument designed to measure the thickness of films deposited on various substrates including those used in semiconductor and magnetic head fabrication. The Model 3000 provides accurate and repeatable measurements in manufacturing and advanced research/development environments.

System Features

The Model 3000 offers these important features and options:

- Linear array head
- Small spot size
- Fast focus
- Fast measurements
- Broad thickness ranges
- Multipurpose thin and thick film capability
- Continuous scanning from 400–800 nanometers
- Windows 95 ™ based graphical user interface
- Standard and customized film programs
- Database storage of measurements
- Real-time sample and model interferogram plotting
- Automated focusing
- Joystick-automated stage
- 32-bit Pentium™ microprocessor
- Joystick, keyboard, and trackball assembly

The measurement range of the Model 3000 extends from 250–200,000 Å (0.025–20 micrometers).

Turning Off the Instrument

To turn off the Model 3000, the user has to be assigned the privilege to exit the Nano system software.

1. Click on the LOGON command button on the Operations Mode screen.

2. Type in your User ID and Password when the User ID/Password window appears.

3. Click on the Exit (Shutdown) item and select:

   - Exit to Windows—if you want to shutdown the Nano system software.

   - Shutdown Windows—if you want to shutdown the complete system.

Section 2
Instrument Components

The following simplified drawing of the Model 3000 gives you a visual reference for a discussion of the instrument components. For greater ease of discussion, the hardware components are further divided into two groups: Measurement system and computer system.
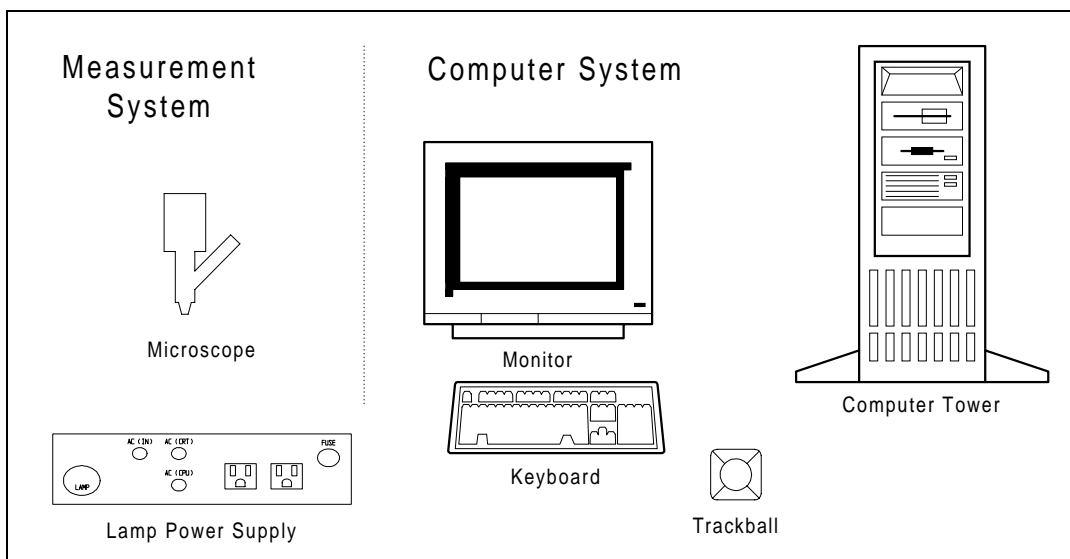
Figure 1-1 Model 3000 Hardware Components

Measurement System

The Measurement System is where the film thickness measurement is taken and converted into digitized data for the computer system.

Microscope Head

In the Model 3000, the spectrophotometer head is mounted on a customized microscope that uses a regulated halogen lamp to provide vertical reflected

light illumination. The standard microscope is equipped with a four position turret. A 10X lens is mounted and supplied, but other lenses are available.

Microscope Stage

The Model 3000 has a manually operated microscope stage that is capable of accommodating wafers up to 150mm. The stage holds the wafer in a perpendicular plane to the optical light path.

Lamp Power Supply

The lamp power supply provides regulated power to the halogen lamp. The lamp power supply is also the distribution point for alternating current (AC) power source for the other hardware components.

Computer System

The computer system has a Pentium microprocessor and uses the Windows 95 operating system software. The supporting computer components are:

Computer Monitor

A 15-inch SVGA monitor displays menus, commands, instructions, and graphs of the sample. The computer monitor specifications are presented in the vendor manual.

Keyboard

The Model 3000 keyboard is primarily used to perform alphanumeric data entry when programming or running the system. However, you can use some function keys as alternatives to clicking the pointer on the corresponding user interface buttons.

Trackball

The graphic user interface pointer is controlled by the trackball. The trackball assembly consists of a large ball and two large buttons that make it easy to operate when wearing gloves. The trackball is used to control the computer pointer, and the buttons are used to control the user interface.

The trackball's left button is used to control the Model 3000 system software. You can select items from the system's menus in two ways:

- Click the pointer on an item to highlight the item and then select it by clicking the pointer on an **OK** button, or

- Double click the pointer on an item to both highlight and select it.

Optional Printer

An optional color graphics printer can be used to print measurements, statistical results, interference plots and wafer maps (on instruments equipped with the wafer mapping option) on clean room-compatible paper.

Section 3
Reference Wafer

Using the proper reference sample is important because the instrument functions by scanning your reference (typically your substrate material) and storing the intensity data in memory. The stored reference data is then used to obtain the reflectance for the film(s) being measured.

You will need one of the following references to perform measurements with the Model 3000:

Standard Reference

A clean, bare silicon wafer is typically used as the reference for all standard measurement programs. For more information on the standard programs, see "Notes on Standard Programs" in Appendix A.

Reflectance Reference

The Reflectance Mode program (12) enables you to measure reflectance relative to silicon. When performing absolute reflectance measurements in a user-defined program, you must also use a bare silicon reference wafer.

Section 4
Measurement Spot

Viewing the wafer is done through an microscope objective tube. The viewing area shows light reflected from the instrument's entrance aperture disk (a mirror in the optical stack with a hole in it). The black measurement spot you see is the actual entrance aperture--the hole in the mirror. The measurement spot is black because that portion of the light is not being reflected from the disk. Instead, it travels into the spectrophotometer head to be measured.

Only the area under the black spot is measured by the instrument because this is the only light that travels into the spectrophotometer head. Use the following guidelines to locate the best point for measurement:

- When measuring on a patterned wafer, position the measurement spot in the center of the feature you want to measure.

- When measuring on an unpatterned wafer, position the measurement spot in the area you want to measure.

The Model 3000 Basics

The following topics are covered in this chapter:

Introduction

The Model 3000 is capable of performing a variety of tasks in the Production Mode (the Operations Mode). This section provides an overview of the features available to the production user, as well as basic instructions on measurement and data analysis procedures.

The following flow diagram shows the path the user follows to make measurements, display and print data, or create an interferogram to analyze sample data.
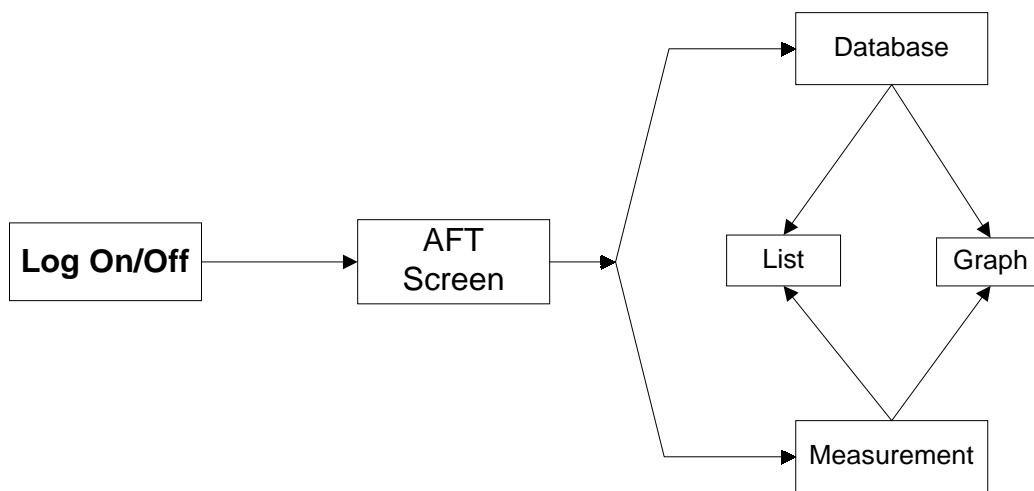
Figure 2-1 Process Flow Diagram

Logging On and Off

When you initially turn on your Model 3000, you are automatically logged onto the Operations Mode, enabling you to perform measurements as well as gather and analyze data. However, if you subsequently press the Log On button, you will need to use a User ID name and password to Log On to the system again.

The User is assigned an User ID name and password, by the system administrator, with certain privileges. This section will assume that the user has only password privileges. The engineering privileges are discussed later in Part 3 of this manual.

Entering a User ID and Password

When an User presses Log On button, the M3000 Log On dialog box appears.

1. Click the pointer in the User ID name field.

2. Type your assigned User ID name.

3. Press the **<Tab>** key or click in the Password field.

4. Type your assigned password.

5. Click on the **Log On** button or press the **<Enter>** key.

The Main Operating Screen appears.

NOTE

If the Log On procedure is not successful, type the User name and password in capitals. The Log On dialog box is case sensitive. If the Log On is still unsuccessful, contact the system administrator at your facility.

Logging Off

To log off the Model 3000:

1. Click on the **F3:Log On** button in the Operations Mode screen or press the **<F3>** key on your keyboard.

   The Log On dialog box appears.

NOTE

At this time, the software leaves the user name and password intact. A nonentity user should have been created for safe guarding the system.

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2. Type the nonentity User ID name.

3. Press the **<Tab>** key or click in the Password field.

4. Click on the **Log On** button or press the **<Enter>** key.

Main Operating Screen

The Operations Mode screen is displayed when you Log On to the system. The rest of this chapter describes the options displayed on this screen and how to use the ones that are available to a operator on the Model 3000. All Operation functions available to the operator are present on this screen. Any function displayed on the screen that is not assigned to the User privilege level is not activated.

The Main Operation Screen contains of the following areas: title band, menu bar, User identification band, program listing area, and action button area.
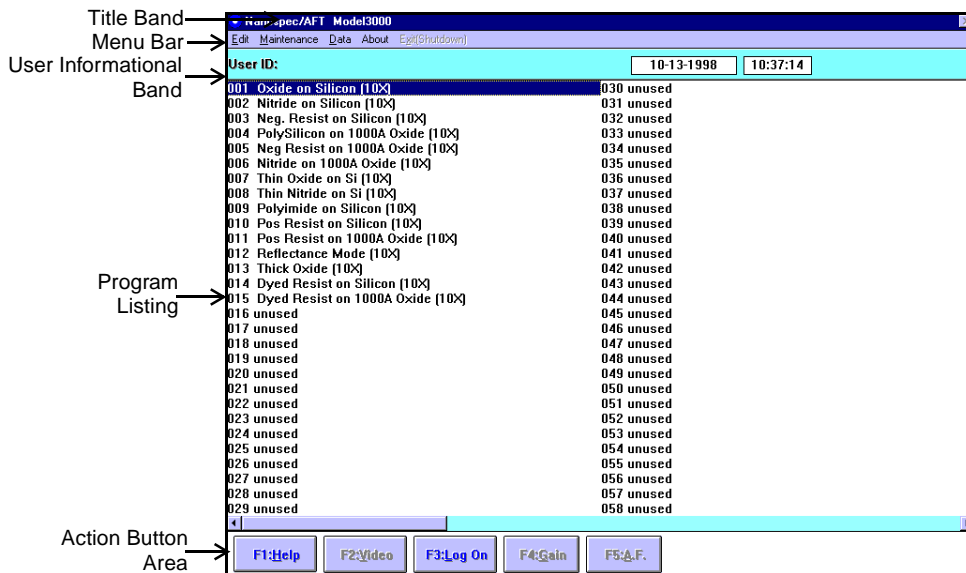
Figure 2-2 Initial Operating Screen

Title Band

The title band displays the screen title.

Menu Bar

The menu bar displays the available option items. The options are:

Edit All functions in this menu item are deactivated for the User assigned with no privileges.

Maintenance This menu item has drop down menu items: **Reference Info.**–selecting this item opens an information window showing the Date and time when the last reference was taken; **Delete Reference**–selection this item deletes the reference measurement stored in memory.

Data This menu item contains the following: **Process Last Saved Measurement Result**—measurements are automatically saved to a database. This item allows the operator to process data after all measurements are completed; **Process Measurement Result**—this item allows the operator to process a measurement just taken without searching the database.

About This menu item contains the following: **AFT**–opens a informational window displaying information about the AFT software; **Windows**–opens a informational window displaying information about the Window software.

Exit(Shutdown) This menu item is only available to users with shutdown privileges and will be discussed in Part 3.

User Identification Band

This band is an information area displaying the user name, date and system time.

Program Listing Area

The program listing area is the main portion of the screen display. This area displays the programs available for measurements.

Action Button Area

This area contains direct action buttons. The buttons can be activated by clicking on the button with the pointer or by pressing the **<Fn>** key displayed in the button.

F1:Help   The **Help** button and **F1** key opens the M3000 Help file.

IMPORTANT

The Help button in most screens are content sensitive. That is, in the Measurement screen, the Help button will open the file and display the information pertaining to the Measurement screen.

F2:Video   The **Video** button and **F2** key is deactivated on the M3000.

F3:Log On   The **Log On** button and **F3** key will open a Log On dialog box. The user ID is not removed until another user has logged on.

F4:Gain   The **Gain** button and **F4** key is deactivated on the M3000. The gain is automatic adjusted by software.

F5:A.F.   The **A.F.** (auto focus) button and **F5** key is deactivated on the M3000.

Selecting Programs

Before a user can take any measurements, a program must be selected and loaded. The main operating screen displays up to 200 predefined programs. The programs have been defined using the instrument in the engineering mode; so the operator can easily measure a sample by selecting and activating a program.

To load a program:

1. Load a reference wafer on the reference platform (right platform) of the stage.

2. In the Program listing area of the display, select a program by clicking on a program to highlight it.

NOTE

Double click or press **<Enter>** mean the same thing. From this point on, double click will be used without referencing the key board. Either method can be used, it is your choice.

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3. Double click on the program.

   The Reference reminder box opens.

4. If the reference time is within your limit, click on
    No.

5. If the reference is out of your limit, click on **Yes**.

    The reference is measured and displays the
    reference measurement in the Measurement
    Screen. See "Measurement Screen" on page 3-8.

Measuring a Sample

After you have selected a program and performed the
reference scans, the instrument is ready to take
measurements.

The general procedure to measuring a sample is the
following:

1. Place a sample wafer onto the stage.
2. Position the stage so that the lens is over the
    desired measurement spot.
3. Select the appropriate program.
4. Using the **Meas** button, measure the sample.

Measurement Screen

The Measurement screen is the work area that is used to display measurement data. To aid in the discussion, the display is divided into four areas. The display areas are:
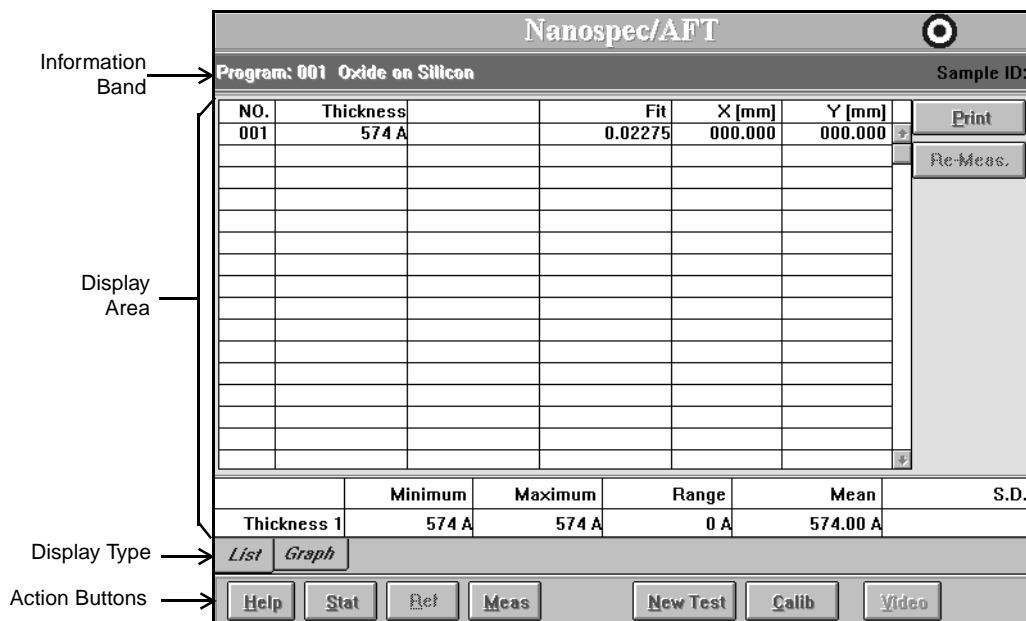
Figure 2-3 Defining the Measurement Screen

Information Band

The Information Band displays Program and Sample ID.

Display Area

The Display Area sets up the data into a visual presentation. There are two display methods: List and Graph.

List Button

The List button is the default display in the above display area. The list is the numerical measurement data.

Graph Button

The **Graph** button displays the measurement data list
in an interferogram graph. There is a possibility to
display two or one of two types of graphs at the same
time:
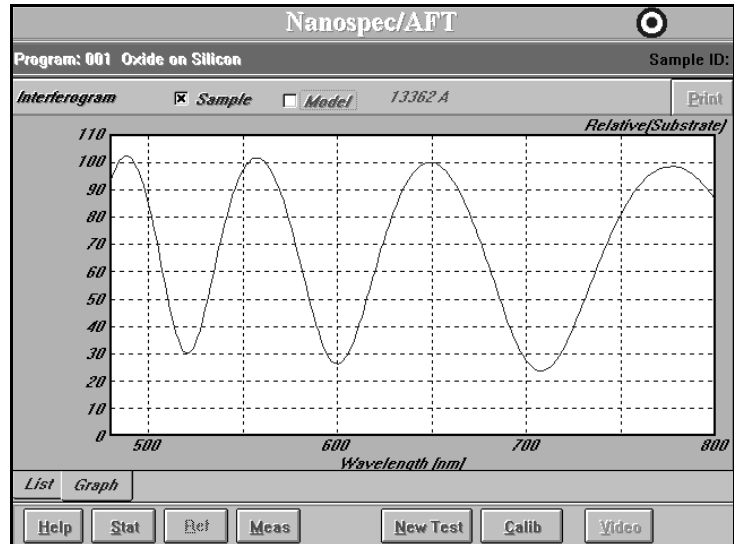
Figure 2-4 Example of Graph Display

Sample Check Box Checking the **Sample** check box, the Interferogram
graph will display the reflectance spectra obtained
from analyzing the sample.

Model Check Box Checking the **Model** check box, the Interferogram
graph will display the computer generated model
obtained from user inputted data and sample
reflective spectra data.

Action Buttons

This screen band contains action buttons use while
taking measurements. The buttons are:

Help The **Help** button is content sensitive. Press to receive
additional information on the screen functions.

Stat The **Stat** button opens another display box displaying
the statistic data. A screen opens and displays a bar
graph of the measurement data.

Ref The **Ref** button is not active when in the operator
mode.

Meas The **Meas** button starts the measurement process.

New Test The **New Test** button saves the measurement data in a database and clears the data from the screen. The screen is ready to start another measurement.

Calib The **Calib** button saves the measurement data and closes the measurement window and returns the Main Operation Screen.

Video The **Video** button is not active in the operator mode.

Mastering The Model 3000

The following topics are covered in this section:

Section 1
Introduction

Introduction

This manual part deals with the engineering mode of operation that is used to create and maintain programs. This section will first discuss the user editor and then discuss the program editor with its other supporting editors. Also, from the AFT screen, there is a menu item allowing the user to Exit(shutdown) the equipment. The two options for exiting are:
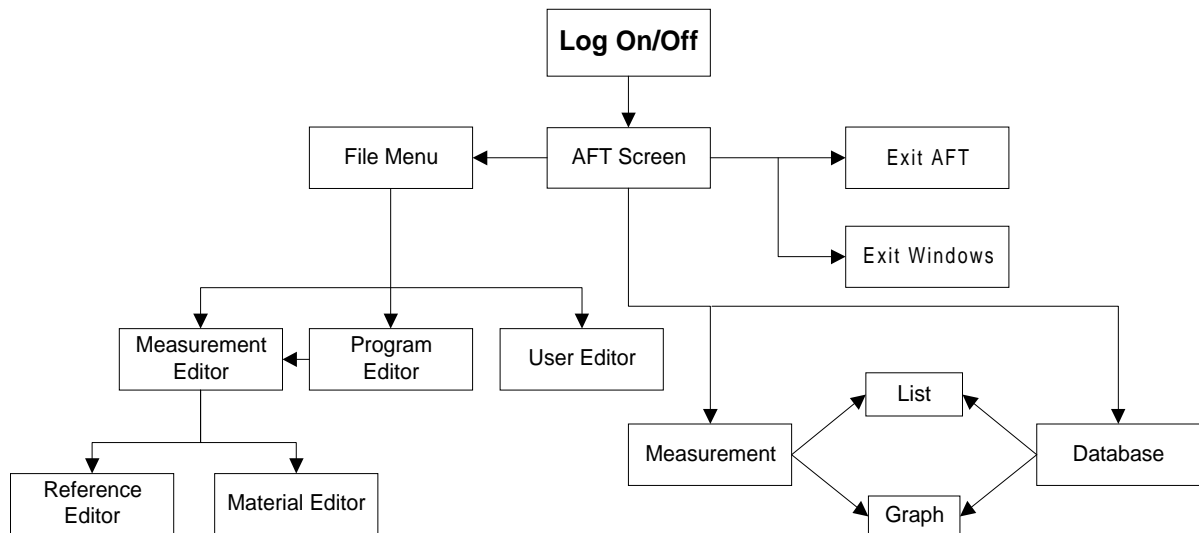
Figure 3-1 Engineering Operation Flow Diagram

Exit AFT
This drop down menu item allows the user to exit out of the NanoSpec AFT software to windows.

Exit Windows
This drop down menu item allows the user to exit out of the NanoSpec AFT software and then exits the Windows software to a DOS system prompt. From the system prompt, the user can safely turn off the equipment.

Creating Programs

Programs are instructions to the instrument about how to take a measurement. These instructions are for a measurement at one measurement point.

General Overview

The Program is a running script of actions the different system parts will be doing and, as the above flow diagram shows, the File drop down menu allows access to the different editors to create this script. The Program script does the following:

1. instructs the microscope how to take the measurement;

2. instructs the software what material is being measured and what reference material to compare it against.

These instructions are predefined script parts that other editors have created and will be assembled in the program editor.

General Procedure

As the flow diagram shows, the individual editors can be access from the File menu or from the Program editor. This general procedure assumes access to other editors from the program editor.

1. From the File drop down menu, select the Program menu item.

   Purpose: Selecting this item opens the Program Editor screen. From this screen, the other editors can be directly opened and, when closing, always returns to the Program Editor screen. For additional information, refer to "Program Editor" on page 3-14.

2. Choose the method to be used in creating a program.

   Purpose: The user can create a program from the start or by using a previous defined program as a template. This procedure

will assume a previous defined program is used as a template.

Procedure: a. Highlight the program number listed in the program list that is going to be used as a template.

b. To the right, click on the copy button and follow the instructions. This will copy the highlighted program to another numbered location leaving the original program intact.

c. To the right, click on the edit button. The Program Editor screen opens. Refer to "Program Editor Screen" on page 3-16.

3. Change the Program Name

Purpose: The program name should be change to describe the new program.

Procedure: a. Type in a new descriptive name that will be a source of identification over a period of time.

b. To the left, click on the Program Name button. This saves the new name.

4. Select the lens that will be used in the measurement.

Purpose: Each program needs a lens for measurements. This assigns the correct lens for the program.

Procedure: a. Click the scroll button on the side of the entry box.

b. Select the a lens magnification (in M3000 the 10X lens is the only lens available).

c. To the left, click on the Lens button. This save the lens selection.

5. Select the measurement program to be used in the measurement.

Purpose: Each program has to have an assigned measurement program. The measurement program can be previously defined or can be defined now.

Procedure: a. Click on the scroll list button to select a previously defined program, or

b. Click on Measurement button on the left side and the Measurement Editor screen opens. Refer to "Measurement Program Editor" on page 3-19.

Maintaining Programs

The NanoSpec 3000 software package does not have a separate utility for managing the different program files. So, maintaining the program files is done through each program editor and Windows' file management facilities. Use each editor's ability to delete, copy, and move files individually within the lists and then use Windows.

General file backup is done through the Windows backup utilities. The directory needing backed up is Nanospec and its subdirectories.

To export files, the windows copy command is used to transfer the file to a diskette. To import files, first ensure that the transfer will not overwrite any files already installed on the system. Then use the Windows copy command to transfer the diskette file to the Nanospec directory.

Section 2
User Editor

Introduction

The Model 3000 contains many features. These features can be assigned or withheld from different users. All features plus a few extras are available to only one person, and that person can then assign privileges to other users. The following discussion is a recommendation for setting up User privileges. This recommendation can be adjusted to fit your needs.

For discussion purposes, Users are separated into four types: System Administrator, Process engineers, Service Engineers and Operators

System Administrator

The Model 3000 is shipped with a special User ID and password, and Nanometrics will tell one person the User ID and password when the instrument is delivered. This User ID and Password is not changeable and should be known only to one person for security purposes.

This person is called the System Administrator and has access to all privileges. The system administrator can then create, edit and delete programs, and the administrator can maintain the system and most importantly assign others to help create programs and maintain the system. The System Administrator should be the only person having access to the User Editor screen, and the administrator will assign selective privileges to other users. All assignments are done in the User Editor dialog box, see "User Editor Screen" on page 3-9.

IMPORTANT

A special note, clicking on the Log-On button does not clear the previous users ID and password. So, a user with no privileges should be assign to the system and known to all users. Then, when a user is done working on the instrument, they can log-on as the no privilege user and the system will be protected.

Process Engineer

The Process engineer is a user that assists the system administrator in creating, editing and maintaining programs and needs the privileges to perform those duties. The possible privileges assign to the process engineer are:

- Program
- Measurement
- Password

And possibly the following optional privileges:

- System Shutdown
- Data Maintenance
- Recalibration
- SECS Operation
- SECS Setup
- Lens Parameter
- Gain[Setup]
- Maintenance Menu

Service Engineer

The Service engineer is a user that assists the system administrator in maintaining the instrument and needs the privileges to perform those duties. The possible privileges assigned to the Service engineer are:

- Program
- Measurement
- Password

And possibly the following optional privileges:

- System Shutdown
- Data Maintenance
- SECS Setup
- Lens Parameter
- Gain[Setup]
- Maintenance Menu
- Model3000 Setup

Operator

The Operator is a user that assists the system administrator in taken measurements. The operator needs to be able to access the initial operating screen, but assigning an User ID allows measurements to be associated with the user.

User Editor Screen

The User Editor screen should only be available to the System Administrator. This allows the system administrator have people trained before allowing access to certain system functions. To enter the User Editor, click on the File item in the Main Menu. Then click on the User item in the drop down menu.

User Dialog Box

1. In the Menu Bar File drop down menu, the User item will open the User Dialog Box.

Figure 3-2 User Dialog Box

From this dialog box, the system administrator can add a new user to the access file, change the access privileges of an user, or delete an user from the access file.

2. Click on the Add New User button.

The User Access Level Dialog Box will appear.
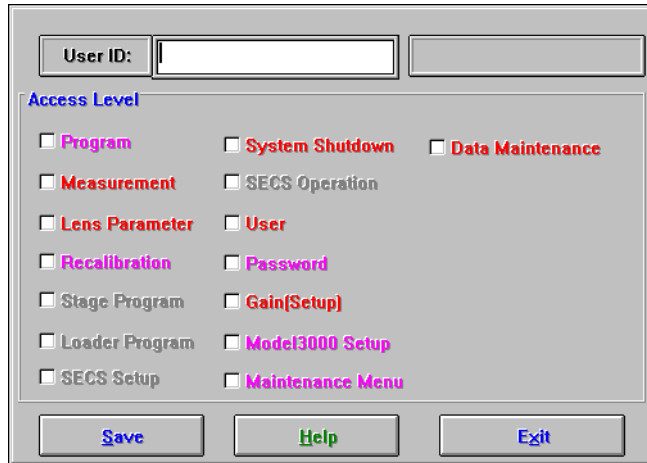
Figure 3-3 User Access Level Dialog Box

3. Select the items that are going to be assigned to the user. (See Access Level dialog box below.)

4. • Click on **Save** button when all selections have been made, or

   • Click on the **Exit** button to cancel the operation.

Access Level Dialog Box

In the Access Level dialog box, the following check box items are available:

Program

Selecting this item gives the user the ability to access the Program Editor. From the Program Editor, the user can create, edit, and delete any measurement program. This item selection will be assigned to most process engineers and service engineers.

Measurement

Selecting this item gives the user the ability to access the Measurement Program Editor. From the Measurement Program Editor, the user can create,

edit, and delete any measurement program. This item selection will be assigned to most process engineers and service engineers.

Lens Parameter

Selecting this item gives the user the ability to access the Lens Parameter dialog box. This item selection will be assigned to most service engineers.

Recalibration

Selecting this item gives the user the ability to access the Recalibration Dialog Box. This item selection will be assigned to most service engineers and selected process engineers.

Stage Program

This item is not available for M3000.

Loader Program

This item is not available for M3000.

Secs Setup

Selecting this item is only possible whenever the system is configured for SECS. This item gives the user the ability to access the SECS Setup menu. This should be assigned to the service engineer. This selection will be discussed in greater detail in Part 4 of the manual.

System Shutdown

Selecting this item gives the user the ability to shutdown the system. This should be a default selection for the service engineer and on need for the process engineer. This selection will be discussed later in this manual.

Data Maintenance

Selecting this item gives the user the ability to access the measurement database for maintenance. This should be a default selection for the service engineer and on need for the process engineer. This selection will be discussed in greater detail later in this manual.

SECS Operation

Selecting this item is only possible whenever the system configuration has SECS enabled. This item gives the user the ability to operate the SECS software. This should be selected for any engineer that requires to use the SECS software. This selection will be discussed in greater detail later on.

User

Selecting this item gives the user the ability to add, delete and change the access level of any user. Only one user with this level of access is allowed to access this screen. So, this selection is reserved only for the System Administrator.

Password

Selecting this item gives the user the ability to change their password at any time. This should be a default selection for all users. The only exception is when a dummy user is created. Example, at the present time, an user can not remove their ID and password from the log-on without shutting down the system. So, an user is added, such as NANO, with no password or access levels selected. Then when an user wants to remove their User ID and Password, they would log-on as NANO.

Gain[Setup]

Selecting this item gives the user the ability to the system gain. This should be a default selection for the service engineer. This selection will be discussed in greater detail in the Maintenance Manual.

Model3000 Setup

Selecting this item gives the user the ability to access the System Configuration Menu. This should be a default selection for the service engineer. This selection will be discussed in greater detail in the Maintenance Manual.

Maintenance Menu

Selecting this item gives the user the ability to access the Maintenance Menu. This should be a default selection for the service engineer. This selection will be discussed in greater detail in the Maintenance Manual.

Section 3
Program Editor

Taking measurements is done with a program. The Program Editor is the tool that allows process engineers to create, edit or delete programs. The program is a set of instructions telling the system how to make the measurement, what lens to use, where and how many measurement spots to measure, where the wafers are located, and how many wafers to measure. These items are the elements of a program.

Program Maintenance Screen

This screen is called the maintenance screen because of the ability to delete, copy, and move program files. To enter the Maintenance screen:

1. Click on the File item in the Menu Bar.

2. Click on the Program item in the drop down menu.

3. Click on the Edit item in the extended menu.

The Maintenance screen will open.

No. Name

001 Oxide On Silicon (10X)
002 Nitride on Silicon (10X)
003 Neg. Resist on Silicon (10X)
004 PolySilicon on 1000A Oxide (10X)
005 Neg Resist on 1000A Oxide (10X)
006 Nitride on 1000A Oxide (10X)
007 Thin Oxide on Si (10X)
008 Thin Nitride on Si (10X)
009 Polyimide on Silicon (10X)
010 Pos Resist on Silicon (10X)
011 Pos Resist on 1000A Oxide (10X)
012 Reflectance Mode (10X)
013 Thick Oxide (10X)
014 Dyed Resist on Silicon (10X)
015 Dyed Resist on 1000A Oxide (10X)
016 unused
017 unused
018 unused
019 unused
020 unused

Edit   Delete   Copy   Move   Print List   Help   Exit

Figure 3-4 Maintenance Screen

On the right side of the screen, the following buttons are located:

Edit   This button loads the highlighted program into the program editor and opens the Program Editor screen. See "Program Editor Screen" section below.

Delete   This button is the main maintenance button. Pressing this button, with a highlighted program in the list, removes the program from the system.

IMPORTANT

There is no Undelete feature. When the button is clicked the highlighted program can not be restored to the list.

Copy   This button will copy the highlighted program to another numbered location. When pressing this button, just follow the instruction at the bottom of the screen.

Move   This button is the second main maintenance button. Pressing this button, with a highlighted program in the list, moves it from one numbered location to another numbered location.

Print List   This button will send the numbered list to the system printer for a hardcopy.

Help   This button will open the content sensitive Help file.

Exit   This button will exit the Maintenance Screen.

Program Editor Screen

To enter the Program Editor screen either click on the Edit button in the Maintenance screen, or click on the Edit Current Program item in the extended menu of the Program selection of File menu. The Program Editor screen will appear.
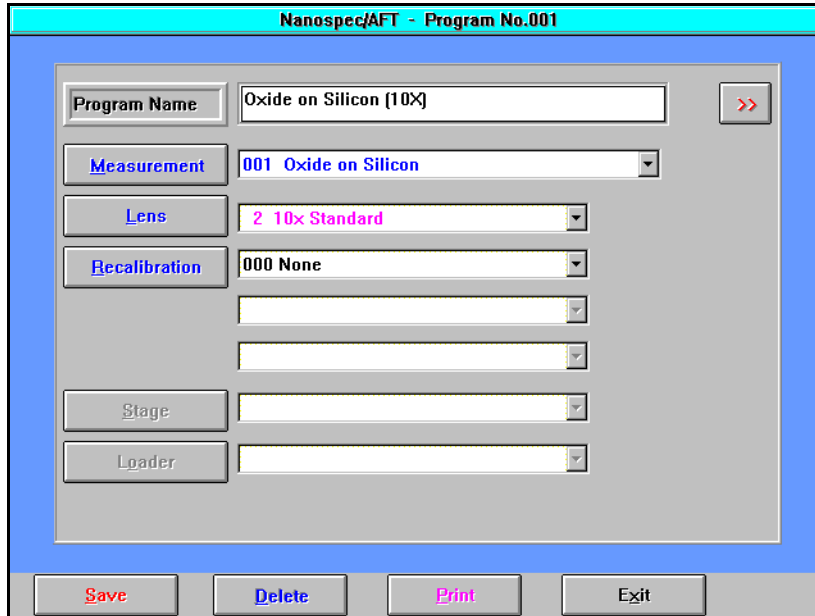
Figure 3-5 Program Editor Screen

Program Name   The Program Name display box shows the program that was highlighted in the program list. If you want to create, copy, move, or edit a program, click on the Program Name button. Otherwise, you can only change the name in the display box. The Program Name button opens a program maintenance screen (See "Program Maintenance Screen" on page 3-14).

To the right of the Program Name is the ⟩⟩ (turn page) button. This button opens Page 2. See "Program Editor Page 2" on page 3-17.

Measurement   The Measurement file defines the properties of the film to be measured and is specific to that film. i.e., Oxide on Silicon. The Measurement has a scroll list displaying all the defined measurement programs on the system. Any defined program is available for the program to use. If you want to create, copy, move, or edit a measurement program, click on the Measurement button. See "Measurement Program Editor" on page 3-19.

Lens The Lens has a scroll list displaying all lenses available to the program. Clicking on the Lens button opens Edit Lens Parameter screen. See "Part 4 Service Manual" for additional information.

Recalibration The Recalibration has three scroll lists displaying all calibration files available to the program. Each scroll list is for one layer. Clicking on the Recalibration button opens Edit Recalibration screen. See "Recalibration Editor" on page 3-29.

Stage This feature is grayed out for the M3000.

Loader This feature is grayed out for the M3000.

Program Editor Page 2

The browse button on the Program Editor screen opens the Page 2 screen. This screen contains options that the program will perform during program execution. The ⏴⏴ (return) button will return the Program Editor screen.
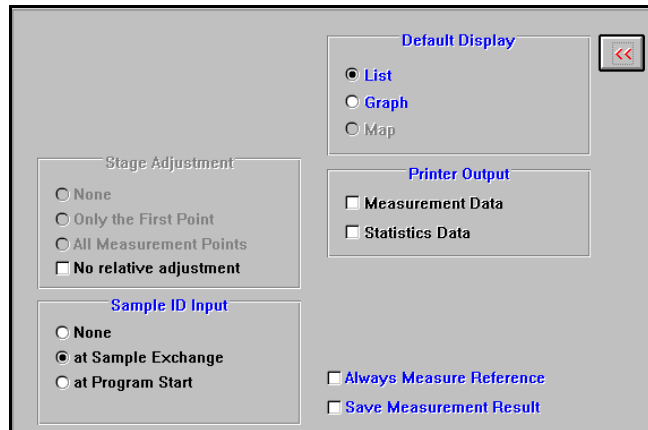
Figure 3-6 Program Options Dialog Box

Stage Adjustment No Relative adjustment selection is only allowed in the M3000.

Sample ID You can select one of the items listed to designate the use of a Sample ID.

Default Display Specifies the display screen at program start-up. You can change the display format freely during program start-up.

Printer Output Specifies automatic output to a standard printer. The Measurement Data check box–specifies printing of a measurement data for each sample measured, and the Statistical Data check box–specifies printing of statistical data for each sample measured.

Always Measure Reference Specifies if the reference wafer is to be measured before measuring the sample wafer.

Save Measure Result Specifies whether or not measurement data is to be saved in a file.

Section 4
Measurement
Program Editor

Introduction

The Measurement Program is the instructions to the system for measuring a wafer sample. The Measurement Program Editor is the tool to create, edit, and delete measurement program files from the system. Below is the main entrance screen to the editor.
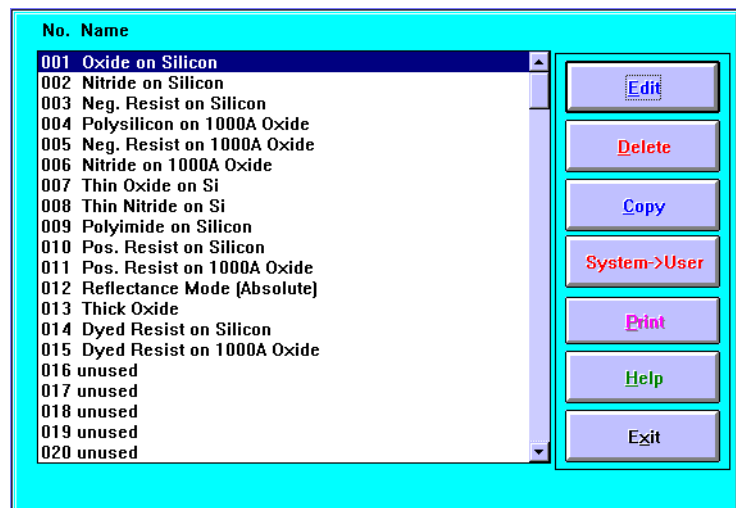
Figure 3-7 Measurement Maintenance Screen

NOTE

Nanometrics has supplied standard programs that are optimized for best performance. It is recommended that they are not changed but copied and then changed, if desired. See Appendix A and B later in this manual.

Edit To edit or create a Measurement Program, the film type, substrate type and material type of the sample is needed. Select the measurement program you want to

edit from the Measurement Program List, or select an unused program number to create a program from the beginning.

Delete If the measurement program is not needed anymore, highlight the program and click on the delete button.

NOTE
Once the program has been deleted, there is no way to Undelete the program. Be sure before deleting any programs.

Copy If a program is to be used as a template, highlight the measurement program and click on the copy button. Follow the instructions appearing at the bottom of the screen.

System->User This button is a toggle switch and only available to the System Administrator. The toggle switch changes the access properties of the highlighted program. When the button displays **System->User**, the access is changed from read only to full; and when the button displays **User->System**, the access is changed from full to read only. This protects programs from being freely edited by other users.

Print Click on this button when a hardcopy of measurement program parameters is needed.

Help Click on this button to open content sensitive Help.

Exit Click on this button to return to the Engineering mode screen.

Measurement Editor Screen

The Measurement Editor screen is used to create and edit measurement program instructions, and the browse button opens page two of the Measurement Program Editor.
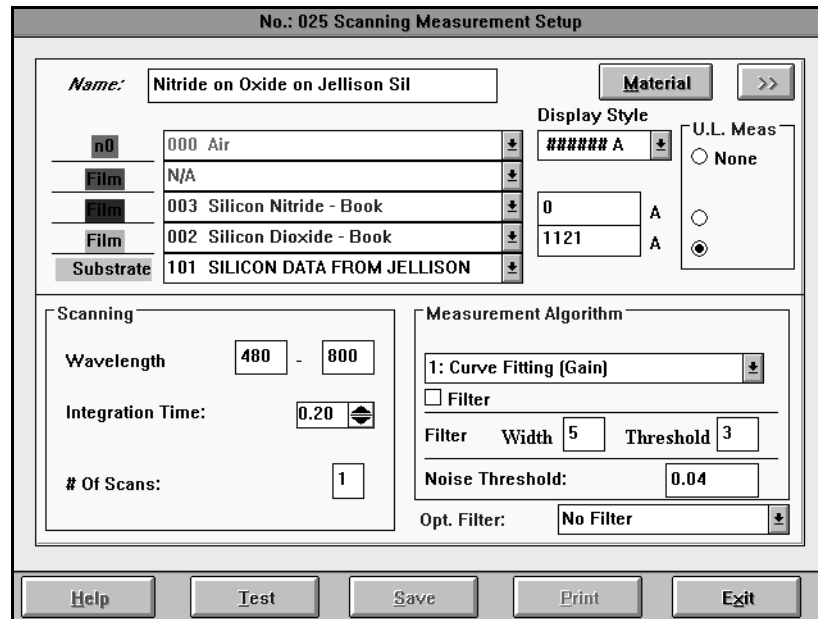
Figure 3-8 Measurement Program Editor Screen

Material Button

The first page of the editor also serves as a gateway to the Material Editor. The **Material** button, to the right of the measurement name, launches the Material Editor. Refer to "Material Editor" on page 3-24.

Command Buttons

At the bottom of the Editor screen are five command buttons. These buttons are direct action buttons that do the following:

Help Click on this button to open a content sensitive Help file.

Test Click on this button to Test the designed program before saving.

Save Click on this button to Save the designed program parameters.

Print Click on this button to send the program parameters to the system printer.

Exit Click on this button to return to the Main Menu screen without saving any program changes.

Measurement Editor Page 2

The Measurement Program Editor has a page two for more parameters. This page will specify the reference file and setup the scaling on the display graph screen.

Figure 3-9 Page Two of Measurement Program

Reference Parameters

The reference parameters are hard coded into the software. The scroll list buttons, on the right, displays the available choices. The Native Film Thickness can be entered into the right entry box, and a prompt can be activated for user input if desired.

Graph Scale Parameters

The Y graph scaling is set in percentages (%). The X graph scaling is a selection of division or interval graph settings. The number of divisions or intervals over the measurement range is entered in the entry box.

About Reference Scans

The Model 3000 stores standard and dark (zero) reference scan data that the computer uses to nullify any arbitrary optical effects that might affect the sample measurement. Before you can perform a measurement with the instrument, valid reference scans must be stored in a disk file.

For more information on obtaining the correct reference sample for your application, refer to "Obtaining a Reference Wafer" in Part 1 of the manual.

Reference Scans A reference scan file is stamped with a time and date. Before a sample measurement is taken, the time and date clock is compared with the time and date stamp and displays a time since last reference scan reminder. For optimum measurement accuracy, a new reference scan is dependent upon the type of material being measured. Contact Nanometrics applications engineering for help in determining the proper time interval between references.

Dark Reference Scans Before a reference scan is taken, a dark reference scan (the "zero scan") is done to account for stray light entering the spectrophotometer head. Use an external dark reference (a dark spot on the stage platform), the film-type program used must have the Zero Scan Option activated in the Reference Editor.

Section 5
Material Editor

Introduction

The Material Editor is used to edit, create or view material files. Each material file holds the optical description for a particular material used either as a substrate material or as a thin film material. Typically, it will only be necessary to create or edit a material file if you wish to measure nonstandard materials or if your process creates films with other than nominal optical parameters. New material files may be created from scratch or by editing an existing material file copied over to an unused material file number.

Create Material Screen

Opening the Create Material screen is done from the Measurement Editor screen. Clicking on the Material button opens the Create Material screen.
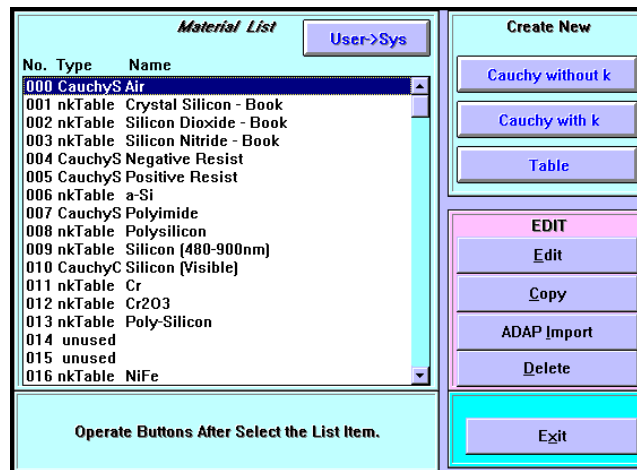
Figure 3-10 Create Material Screen

From this screen, the user can create a refractive constant file, copy a predefined file and edit it to create a modified file, or edit a predefined material file to adjust the refractive constants.

Create New Buttons

When the user wants to create a new material file, click on one of the three buttons:

Cauchy without *k*

The **Cauchy without *k*** button opens a dialog box to entered polynomials to describe *n* as a function of wavelength. The Cauchy formula is:

$$\text{lambda} = \lambda = \text{wavelength in nm}$$

$$n(\lambda) = Na + \frac{Nb}{\lambda^2} + \frac{Nc}{\lambda^4}$$

Figure 3-11 Cauchy without *k* Dialog Box

Insert the minimum and maximum Wavelength Range (in nanometers) into the entry boxes.

Command Buttons

Graph If a graph of the constant over the range, click the **graph** button.

Print To print out the constant values, click on the **Print** button.

Save To save the values into nonvolatile memory, click on the **Save** button.

Exit To exit the dialog box and return to the Create Material screen, click on the **Exit** button.

Cauchy with *k*

The **Cauchy with *k*** button opens a dialog box to entered polynomials to describe *n* and *k* as a function of wavelength. The Cauchy formula is:

$$\text{lambda} = \lambda = \text{wavelength in nm}$$

$$n(\lambda) = Na + \frac{Nb}{\lambda^2} + \frac{Nc}{\lambda^4}$$

$$k(\lambda) = \frac{Ka}{(Kb - \lambda)^2} + Kc$$

Figure 3-12 Cauchy with *k* Dialog Box

Insert the minimum and maximum Wavelength Range (in nanometers) into the entry boxes.

Command Buttons

Graph If a graph of the constant over the range, click the **graph** button.

Print To print out the constant values, click on the **Print** button.

Save To save the values into nonvolatile memory, click on the **Save** button.

Exit To exit the dialog box and return to the Create Material screen, click on the **Exit** button.

Table

The **Table** button opens a table dialog window. The table format is suitable for all materials, but is uniquely suited to materials whose n and k values vary with wavelength in an irregular way.
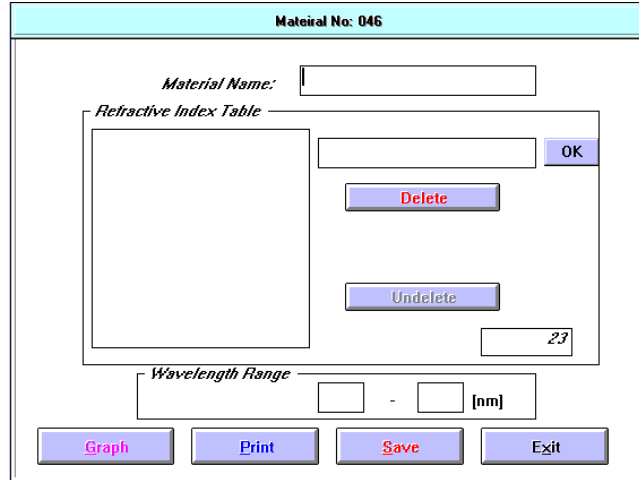
Figure 3-13 Table Dialog Box

The table format allows the n and k to be defined at individual wavelengths. The wavelengths are arbitrary but close enough to adequately describe the material. Substrate material index of refraction (n) should be known to ±0.01 and films to ±0.001 if possible. All materials extinction coefficient (k) should be known to 5% or better.

If a wavelength has been edited, the lines in the table will be sorted so that all of the lines in the table are in increasing wavelength order.

To add a line in the middle of the table, click on the wavelength after the last line of the table. Enter the desired wavelength and press the TAB key. Enter the n value and press the TAB key again. Enter the k value and press the TAB or ENTER key. The new line will be inserted into the appropriate place in the table.

To delete a line in the table, click on the line in the table to highlight the line. Then click on the **Delete** button. The last line that was deleted can be Undeleted.

Command Buttons

Graph If a graph of the constant over the range, click the **graph** button.

Print To print out the constant values, click on the **Print** button.

Save To save the values into nonvolatile memory, click on the **Save** button.

Exit To exit the dialog box and return to the Create Material screen, click on the **Exit** button.

Edit Buttons

Edit Click the **Edit button to modify the contents of the highlighted Material file.**

Copy Click on the **Copy** button to copy the highlighted Material file to a unused number. After clicking the button, follow the instruction.

ADAP Import This button is not implemented for the Model3000.

Delete Click on the **Delete** button to delete the highlighted Material file. There is no undelete for the button.

Exit Button

Exit from the Create Material screen and returns to the Measurement Editor screen.

Section 6
Recalibration Editor

Introduction

The Recalibration function is to create or edit compensation for measurement errors between instruments. These compensation graphs are created from known sample thicknesses and actual measurements. The graph must have a minimum of two or a maximum of five measurement points. Graphs contain minimum of two points or a maximum of five points of measurement. Graphs of two points do not create a true representation of the slope, so the five point graph will create a more accurate representation of the slope. Editing or creating the recalibration file is discussed below.

Recalibration File Window

From the main operation screen, clicking on the File menu item and selecting Recalibration from the drop down menu will open the Recalibration File window.

From this window, you can select an existing file to edit, or delete an existing file, or select an unused number file to create a file. The command buttons are:
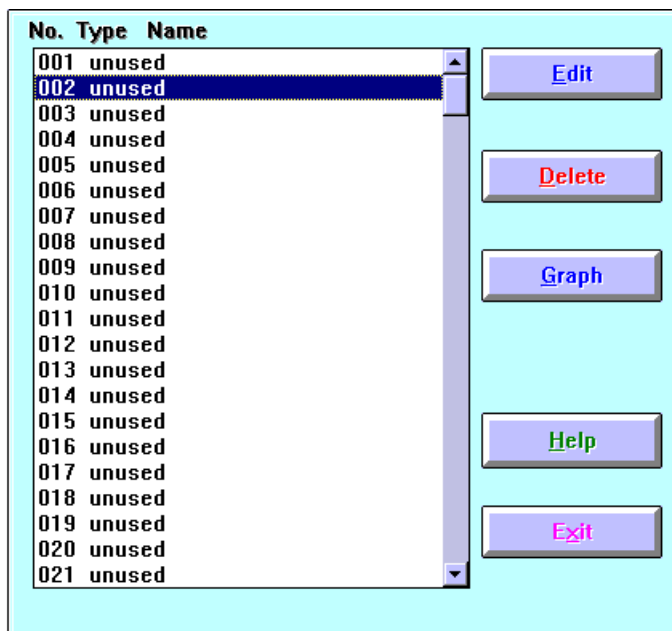
Figure 3-14 Recalibration File Window

Edit   Selecting a number file and clicking on this button will open the Recalibration dialog box with the files parameter inserted for editing.

Delete   Selecting a number file and clicking on this button will clear the parameters from the highlighted file.

Graph   Selecting a number file and clicking on this button will draw a graph of the parameters of the highlighted file.

Help   Clicking on this button will open a content sensitive Help file.

Exit   Clicking on this button will close the Recalibration file window and return the operation window without saving any changes.

Recalibration Parameter Window
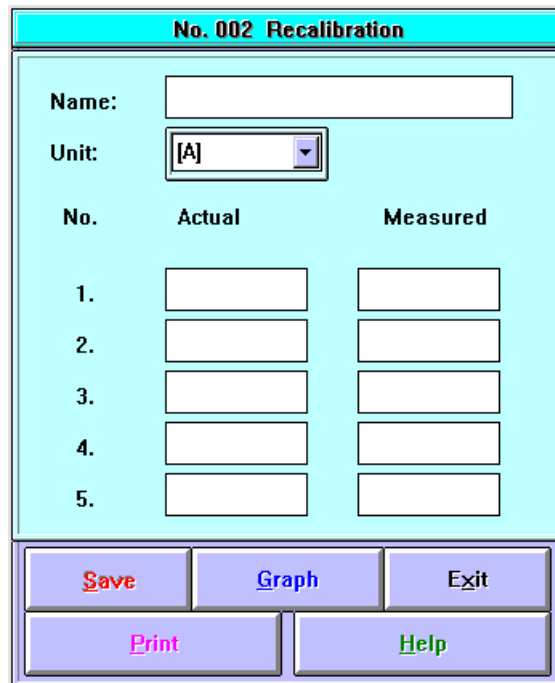
The Recalibration window is where parameters are enter into the file. The items to be specified for the recalibration file are: file Name, Units of Measurement, and actual and measured film thicknesses.

NOTE

The Recalibration program performs linear interpolation between adjacent data points. It is recommended to interpolate within a wide film thickness range.

Entry Items

The entry items are:

No. 002 Recalibration
Name:
Unit: [A]
No. **Actual** **Measured**
1.
2.
3.
4.
5.
Save   Graph   Exit
Print   Help

Figure 3-15 Recalibration Window

Name   Enter a name for the file. This name is usually used to identify what material or substance is being recalibrated. Ensure there is a name entry.

Unit   Enter the units of measurement to be used in the measurement. The units are:

• A for Angstrom,

• nm for nanometer,

• um for micrometer.

Actual Thickness Enter the Actual (known) thickness in these entry boxes.

Measured Thickness Enter the measured thickness in these entry boxes. Two entries are needed but five entries give better accuracy.

Command Buttons

The command buttons are:

Save Saves the recalibration parameters.

Graph Draws and displays the actual and measured parameter points in a graph.

Exit Returns the Recalibration List window.

Print Prints the parameters displayed on the screen.

Help Opens a content sensitive Help file.

Model 3000 Maintenance

Part Four contains the following sections:

Section 1
Introduction

Introduction

The NanoSpec 3000, hereafter referred to as Model 3000 or M3000, is an instrument designed to measure the thickness of films deposited on various substrates including those used in semiconductor, flat panel display, and magnetic head fabrication. The Model 3000 provides accurate and repeatable measurements in both manufacturing and research and development environments. This section will provide procedures for intrument maintenance and adjustment to maintain the instrument's accuracy.

> **CAUTION** This section describes procedures and instructions for configuring and maintaining the instrument. These procedures and instructions when misused could damage the instrument; so, this part of the manual should be used by personnel that has attended Nanometrics Service Training classes.

System Components

The Model 3000 contains two major system components: Measurement System and PC Computer System. The second configuration, Model 3050, contains three major system components: Model 3000 components plus an Auto Loader.

Measurement System

The Model 3000 measurement system is a linear array head (LAH), a customized microscope, a nd a vertical reflected light illumination.

Linear Array Head

The LAH is a self contained unit that needs no service.

Customized Microscope

The standard microscope has a four position turret equipped with a 10X objective for measurements.

Light Illumination

A halogen lamp is used for illumination and manual optical colored filters are available for use during a measurement.

Auto Loader

The Model 3000 has an optional Auto Loader available. When the Auto Loader is installed and configured for the system, the model number changes to Model 3050. The Auto Loader adds wafer handling automation to the instrument. See vendor manual for the Auto Loader information.

Hardware Specifications

The NanoSpec film thisckness measurement system is a small spot spectroscopic reflectometer, built on a simple to use tabletop platform.

IMPORTANT Hardware specifications are subject to change without notice. For the latest information, please consult the latest version of the specification document.

Performance

Number of Films	Up to three films
Wavelength Range	400-800nm
Film Thickness Range	100–200,000Å (0.00001–20μm)
Reproducibility	<2Å (1σ static repeatability)
Measurement Time	<3 seconds

Hardware Configuration

Wafer Size	100mm, 125mm, 150mm and 200mm
Optics	White light halogen lamp Holographic grating Linear Diode Array Detector 10X Objective Lens
Spot Size	25μm
Computer	Pentium-PC with high capacity disk drives
Data Management	Statistics, Histogram and Mapping, Print and Export (CVS Excel format)

Facilities

Electrical	100/120 VAC, 50/60 Hz, 5 amps

System Dimensions

Microscope	13″W (34 cm) X 23″D (57 cm) X 26″H (65 cm)
Computer	7″W (18 cm) X 16″D (41 cm) X 14″H (35 cm)
Monitor	14″W (36 cm) X 18″D (45 cm) X 16″H (41 cm)
Lamp Power Supply	7″W (18 cm) X 13″D (32 cm) X 3″H (8 cm)

Shipping Weight

3000	176 lbs (80 kg) approximate

Environmental Specifications

Operating Temperature	45°F to 80°F (7°C to 27°C)
Humidity	20% to 80%, non-condensing

Section 2
Installation

Introduction

The Model 3000 is assembled, calibrated and tested at Nanometrics facilities and then disassembled for shipment to the customer's facilities. At the customer site the instrument is to be unpacked and re-cabled. The following procedures are general and will vary according to customers specifications.

Setup

IMPORTANT   The following procedure is used to setup the Model 3000/3050 at the customer site and should only be performed by Nanometrics representatives or Nanometrics trained service personnel.

1.   Inspect the shipping carton for any visible damage.

NOTE   If the instrument is Model 3050, remove the registration plate first. The registration plate size will vary depending on the loader model. The registration plate has to be positioned before installing the other components.

2.   Open the shipping carton and remove the microscope stand.

3.   Position the microscope stand on the table (or on the registration plate).

4.   Remove the computer and place it on the floor under the microscope stand.

5.   Remove the computer monitor, keyboard and trackball, and position these items on the right side of the microscope stand.

NOTE   The Model 3050 loader is mounted on the left side, and the stage moves to the right. So, place the monitor and keyboard in a position that is clear of the stage movement.

6.   Remove the package of cables from the shipment carton.

The instrument is now ready to be re-cabled.

Re-cabling

Using the Model 3000 Cabling Diagram in the back of this manual.

1. Connect the trackball to the computer mouse input port.
2. Connect the keyboard to the computer keyboard connector.
3. Connect the monitor to the computer monitor output connector.

> **CAUTION** To ensure correct electrical loads, external equipment AC power
> cables are the only AC cables connect at this time. Do not
> connect the facility AC power at this time.

4. Connect the monitor AC power cord that is attached to the Lamp power supply.
5. Connect the monitor AC power cord that is attached to the Lamp power supply.
6. Connect the monitor AC power cord that is attached to the Lamp power supply.
7. Connect the head 15 pin cable to the labeled computer board connector.
8. Connect the head BNC cable to the label computer board connector.
9. Connect Video Cable to the VGA card BNC connector and feed the cable through the controller rear panel slot.
10. Connect VGA card Video Cable to the monitor.
11. Connect the Lamp Cable to the Lamp power supply and connect the other cable end to the lamp housing connector.

> **NOTE** If the Auto Loader is to be installed, refer to the Auto Loader
> manual for installation instructions before continuing.

12. Connect the main lamp power supply cable able to the facilities AC power source.

The instrument is now ready for the Setup Procedures.

Section 3
System Overview

Introduction

The NanoSpec 3000 is a sensitive metrology measurement instrument. The instrument is compartmentalized into two different systems: Metrology computer system and optical measurement system. This descriptive overview will describe the systems present in all M3000 instruments. During the overview, refer to the Model 3000 system component figure below.
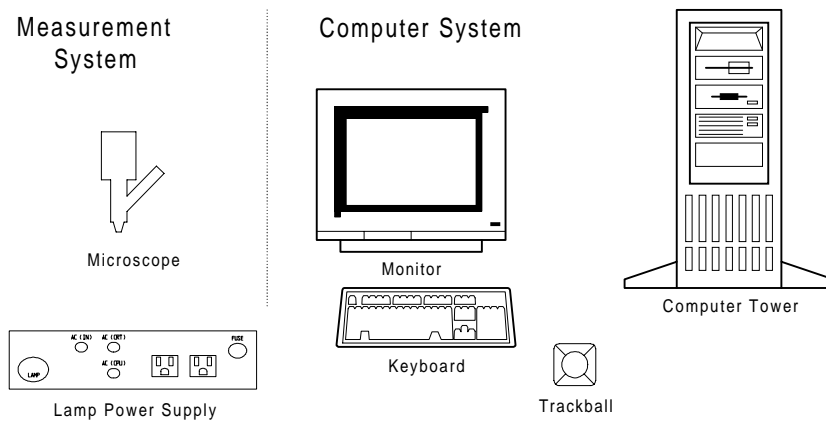
Figure 4-1. Model 3000 System Components

Measurement System

The Measurement System consists of the LAD measurement head mounted on top of the microscope head and the lamp power supply. These assemblies become the metrology measurement portion of the instrument.

The facility AC power is distributed through separate power cord outlets from the lamp power supply. This provides a means of one main AC switch controlling the AC power for the whole system.

Computer System

The main Computer used in the NanoSpec 3000 instrument is an Pentium™ microprocessor with Windows™ 98 operating system. The computer has a 2.1 GByte hard disk drive and SVGA monitor.

Section 4
System Setup

Introduction
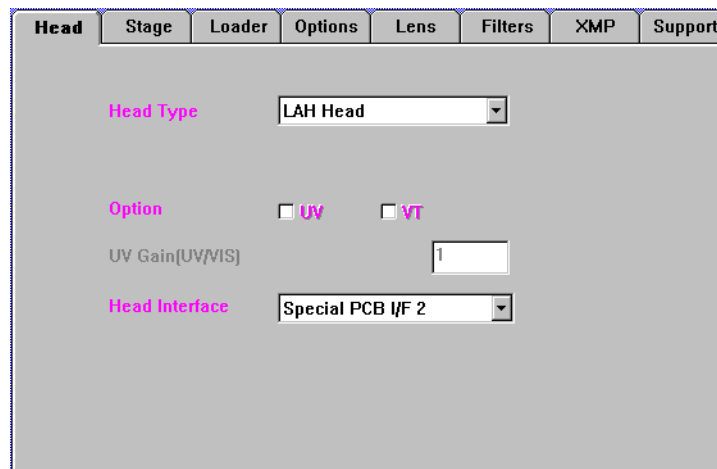
The Model 3000 has been setup and tested at the Nanometrics facilities. This section is used mostly to aid in troubleshooting a instrument malfunction.

System Setup

From the Edit drop down menu, click the System Setup item to open the System Setup window. The System Setup window contains eight tab pages for setup parameters.

Head

The Head tab page is the default opening page. The default setting for the M3000 is LAH Head, Special PCB I/F 2 and, if the system is configured for the optional UV, the UV option box is selected. The VT option is not available.
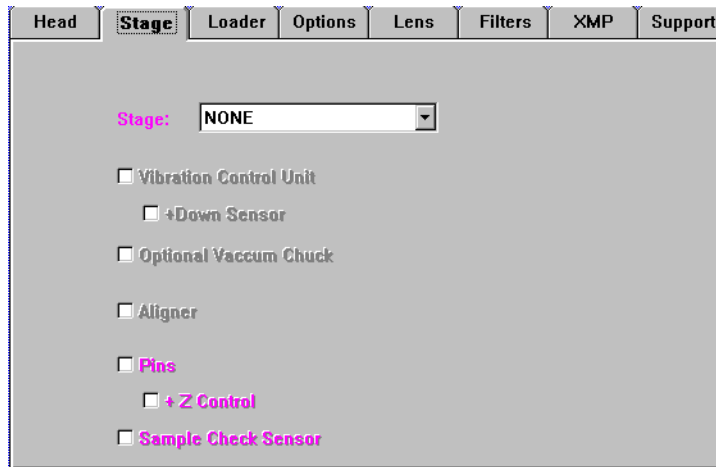
Figure 4-2 Head Tab Page

Stage

The Stage tab page is the second setup page. The stage is Standard Ver. 1.0 and only the Optimal Vacuum Chuck is available for selection. The Vacuum Chuck is selected for Model 3050.
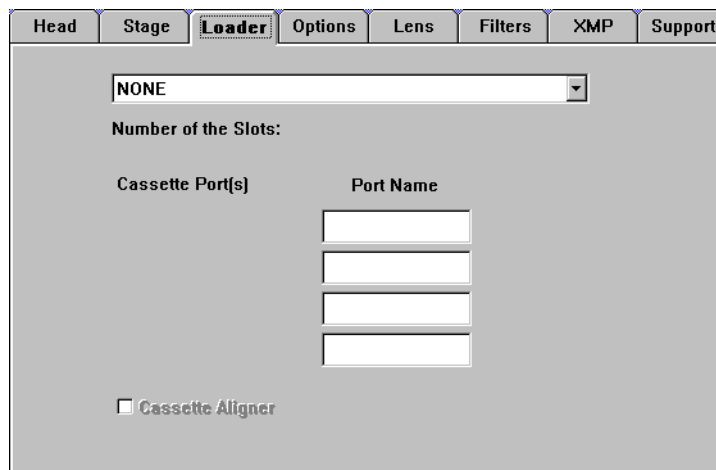
Figure 4-3 Stage Tab Page

Loader

If the system is configured for the auto loader, the Loader tab page is for the auto loader parameters. The Model 3050 uses the Olympus Loader and is a completely manual piece of equipment. No entries are needed on this page.

Figure 4-4 Loader Tab Page

Options

The Options tab page is used to configure the system for the following:

Figure 4-5 Options Tab Page

Language

The Language to be displayed on the screen is English.

P.R. System

The pattern recognition (P.R.) option is not available for Model 3000/3050.

Video

The Video option box is marked and the Flash Point card type is selected from the drop down list.

AutoFocus

The AutoFocus (A.F.) option box is marked for automatic focusing.

UV Auto Shutter

The UV Auto Shutter option box is marked for automatic shutter action.

Auto Filter

The Auto Filter option box is marked for automatic filter selection.

Signal Light Tower

The Signal Light Tower option is not available for Model 3000/3050.

Sample ID Reader

The Sample ID Reader option is not available for Model 3000/3050.

SECS-II

The SECS-II option box is marked when the SECS software package has been installed on the instrument.

Mini. Printer

The Mini. Printer option box is marked when the miniprinter is configured in the system. The character line width is selected from the scroll box.

Lens

The Lens tab page is used to define the positions of the rotary lens mount. There is a possibility of four lens positions. In Model 3000/3050, position four is not available. The rotary turret has one fixed mounting position, and the other mounting positions are adjustable to compensate for centering imperfections. The fixed mounting position has the highest power lens mounted and is called the parfocal and parcenter reference position; position three is the parfocal and parcenter reference position.
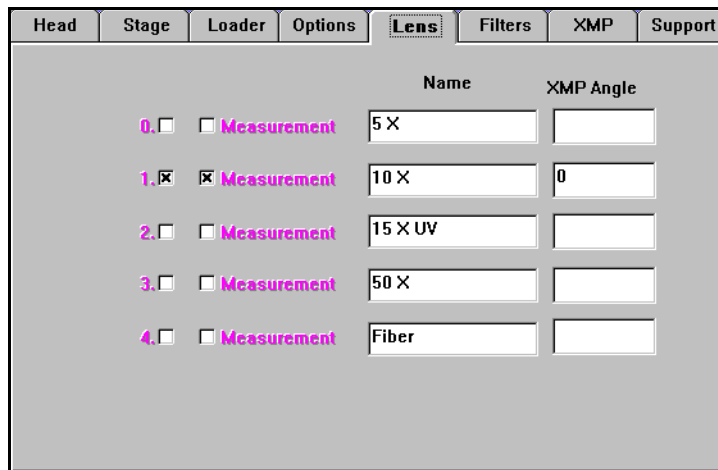
Figure 4-6 Lens Tab Page

All used lens positions will also be checked as a measurement lens, and a descriptive name assigned.

Position 0

Lens position 0 is the first clockwise position from position 3. This position contains the 4X magnification lens.

Position 1

Lens position 1 is the second clockwise position from position 3. This position contains the 10X magnification lens.

Position 2

Lens position 2 is the third clockwise position from position 3. This position contains the 15X magnification lens which is the UV lens.

Position 3

Lens position 3 the is parfocal and parcenter refernce position, and this position must contain the 40X magnification lens, or the highest manification lens mounted on the system.

Position 4

Position 4 is not used in Model 3000/3050.

Filters

The Filters tab page is used to define the filters placed in the filter wheel. Position one is a yellow filter by default passing wavelenghts 400–900nm. Position two is usually an orange filter passing wavelenghts 500–900nm. Position three is a open filter position passing wavelenghts 200–900nm. These filter selections are subjected to change,

Figure 4-7 Filters Tab Page

XMP

The XMP tab page is not used on the Model 3000.

Support

The Support tab page lists Nanometrics phone numbers for support services.

Section 5
Preventative Maintenance

Introduction

The Model 3000/3050 is a very reliable instrument, but it does need preventive maintenance periodically. This section will suggest a time interval for needed maintenance checks. The check procedure suggestions are minimum and should be modified with time and experience.

Periodic Schedule

The following time schedule is presented as a guide. Each facility installation can be different, adjust the periodic schedule to fit the facility and instrument use.

Daily Maintenance

Approximate time required: 10 minutes.

Verify measurement performance for:

- Accuracy
- Precision

Every 2000 Hours

Approximate time required: 1 hour.

- Replace lamps and perform lamp alignments.
- Verify measurement performance.

Quarterly Maintenance

Approximate time required: 1½ hours.

1.   Verify that facility electrical power is at the proper level.
2. Verify that lamp power supply is at proper voltage.
3. Check objective lens for contamination.
4. Verify measurement performance.

Halogen Lamp Replacement

The Halogen Lamp in the visible light source housing has a six months life expectancy. The lamp should be replaced before the end of the life expectancy to maintain a maximum visible light spectrum. Replace the lamp with Nanometrics P/N 9400-0048.

Lamp Removal and Replacement

1. Perform a normal system shut down procedure then turn off the system.

> **WARNING** **The lamp and housing are very hot. Allow some time for the housing and lamp to cool down and handle the lamp and holder carefully.**

2. Loosen the knurled Y-axis lamp adjustment screw on the Halogen lamp housing.
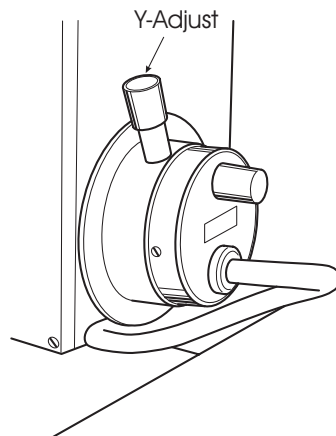
Figure 4-8 Y-axis Lamp Adjustment Screw

3. Rotate the halogen lamp holder toward the cut-out slot, and then pull the holder straight out.
4. Using a pair of long nose pliers, grasp the lamp pins near the socket.
5. Press down the spring socket holders and remove the lamp.
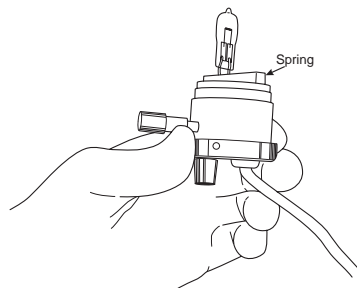
Figure 4-9 Lamp Holder Assembly

6. Properly dispose of the used lamp.

CAUTION   Because hand oils will cause lamp hot spots and drastically reduce lamp life, the following should be performed while wearing un-powdered vinyl gloves:

---

7. On the cellophane bag end containing the lamp pins, tear or cut open the bag.

    a. Using a pair of long nose pliers, reach into the cellophane bag and pull the lamp partially out of the bag.
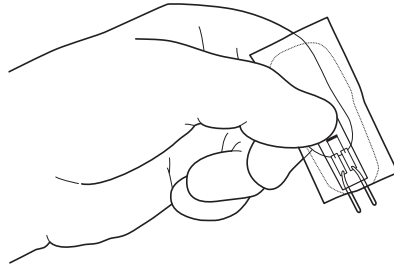
Figure 4-10 Lamp Pins and Bag

    b. Holding the lamp and cellophane bag, press down the spring socket holders and insert the lamp into the socket.

    c. Release the spring socket holders and remove the cellophane bag.

8. Reinsert the lamp holder into the lamp housing and loosely tighten the Y-axis adjustment screw.

9. Power up the system.

Lamp Adjustment

---

10. Move the stage so the light spot is projected on the lowest portion of the stage.

11. Adjust the X and Y adjustment screws until the lamp filament is centered in the light spot.

12. Perform the instrument's normal daily calibration procedure.

The Halogen lamp has been replaced, and the instrument is now ready for service.

Section 6
Adjustments

Introduction

The NanoSpec 3000 Series instrument is adjusted and tested at the Nanometrics facilities but, at the time of delivery, additional adjustments may be needed at the customer's facilities. And this section also covers some of the frequent checks or adjustments.

Lamp Power Supply

The visible lamp power supply contains a +12 VDC supply. Remove the top cover of the lamp power supply to reveal the wire terminals and adjustment pot.

Meter (+) Lead	Meter (-) Lead	Adjust	For Voltage
Term. 1-Yel Wire	Term. 2-Blk Wire	Pot VR 1	+12 VDC ±0.2v

Section 7
SECS Setup

Introduction

The M3000 contains a SECS Communication package in the software. This section will describe the setup procedure for the equipment (M3000) to communicate with the Host computer.

SECS II Setup Screen

Specifies the parameters of the SECS communication protocol. For detailed software setup information refer to the SEMI Standard Manual.
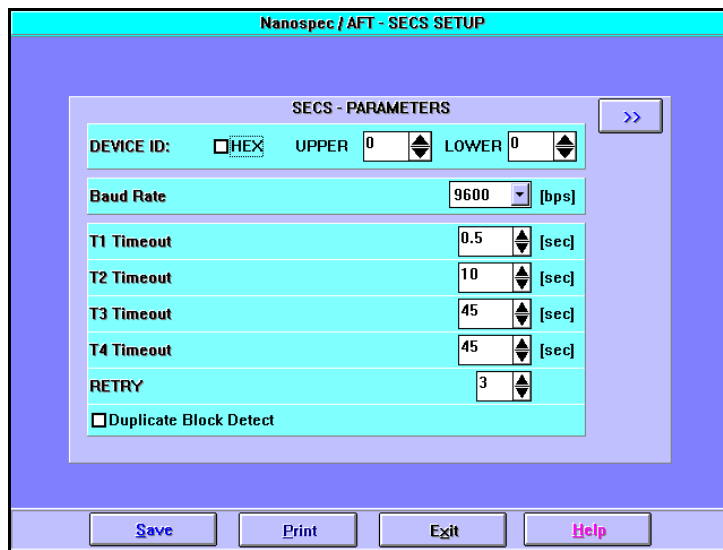
Figure 4-11 SECS Setup Window Page 1

Screen Command Buttons

Save Button

Saves the setup values. The setup values does not take effect until exiting the Setup window.

Print Button

Prints the setup values if the system has a printer onfigured.

Exit: Button

Terminates the SECS Parameter Setup. The saved setup values will take effect immediately after exiting.

Help Button

Displays the online Help file.

Setup Page 1 Screen

The Setup Page 1 Screen is the hardware protocal page. Table 1 shows the default settings for this sceen:

Table 1: Communication Parameter Setup

Parameter	Function	Default	Range	Precision
BAUD RATE	Specifies the speed of the serial interface.	9600bps	300-9600bps	
Upper Device ID	Identification number assigned to the equipment. (upper byte of Device ID.)	-------	0 - 127	1
Lower Device ID	Identification number assigned to the equipment. (lower byte of Device ID.)	-------	0 - 255	1
T1 Timeout	Detects inter-character trouble.	0.5sec	0.1 - 10 sec	0.1sec
T2 Timeout	Detects lack of protocol response.	10sec	0.2 - 25sec	0.2 sec
T3 Timeout	Detects lack of reply message.	45sec	1 - 120 sec	1 sec
T4 Timeout	Detects inter-block trouble in multi-block messages.	45sec	1 - 120 sec	1 sec
Retry	Maximum number of retries at the sending side.	3	0 - 31	1
Duplicate Block	Option for detecting duplicate blocks.	on	on/off	

Setup Page Two Screen

The Page two screen is used to define the message protocol between devices. There are three definition parts on this page.
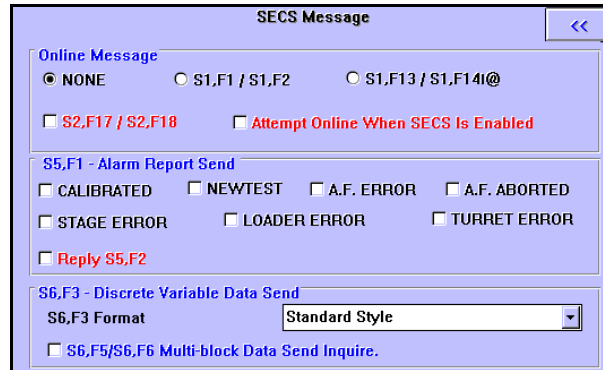
Figure 4-12 SECS Setup Window Page 2

Online Message

Acknowledgement messages when going on line.

1. Select one of the following:

    a. None—The equipment goes on line without issuing an acknowledgment message.

    b. S1,F1 / S1,F2—When the equipment goes on line, it sends S1, F1 (Are you there request) and waits to receive S1, F2 (Online data). As soon as this communication is successful, the equipment knows that it is communicating with the Host.

    c. S1,F13 / S1,F14—Online status is acknowledged according to the GEM standard. The GEM standard is not implemented at this time.

2. Check S2,F17 / S2,F18 box—the system automatically synchronizes its time and date with the host computer when going online.

3. Check Attempt online when SECS is Enabled box—the equipment attempts to go online when SECS is selected. When this check box is checked, the SECS interface is changed over from Disable to Enable and an online test is carried out automatically.

S5,F1 - Alarm Report Send

The Alarm Report Send section defines what errors and how formated is sent to the host. The different erorrs are: Calibrated, Newtest, A.F. Error, A.F. Abort, Stage Error, Loader Error, and Turret Error. See the "SECS Communication Standard" section in the "Operator User Manua"l. The S5, F2 Reply check box is checked if the equipment is going to exspect a reply.

S6,F3 - Discrete Variable Send

The Discrete Variable Send section defines the format of message S6,F3. The Standard Style is the default. The S6,F5/S6,F6 Multi-block Data Send Inquire check box is checked for the equipment to request the host for permission to send large amounts of data in a different format. See "SECS Communication Standard " in the "Operator User Manual".

Appendix A
Notes on Standard Programs

This appendix lists important information about each of the standard programs. Standard programs may be used by selecting them from the main menu, or when creating a user-defined test program.

Program 1: Silicon Dioxide on Silicon

Use this program to measure silicon dioxide on silicon prepared by thermal oxidation or deposition. Measuring highly doped silicon dioxide may affect accuracy because heavy doping changes the film's optical properties. This program should be used to measure films greater than 250Å.

Program 2: Silicon Nitride on Silicon

Use this program to measure silicon nitride that has been chemically deposited on silicon. Measuring plasma nitrides may be less accurate than measuring chemically deposited nitrides because the varying stoichiometry of plasma films can cause measurement error.

Frequently, the refractive index (if known) can be used to scale results obtained from plasma nitride samples. However, creating a user-defined program for a particular nitride to be measured that has the refractive index appropriate for that nitride would be the best way to scale the results of the nitride measurements.

Program 4: Polysilicon on Oxide

Accurate measurements of polysilicon requires accurate entry of the underlying silicon dioxide thickness. An error in underlayer thickness could result in an error in the measured polysilicon thickness.

IMPORTANT
The default optical constants (the refractive index and the absorption values) for Program 4 may not work well for your particular polysilicon sample, since different types of polysilicon films exist, especially if substrate is Amorphous Si. Therefore, you may need to create a user-defined test with different values for the refractive index (n) and absorption (k) for your particular sample.

For assistance in determining the degree of accuracy required for the underlayer thickness value, call the Nanometrics Applications Engineering Department at (408) 746-1600 or (800) 955-6266.

Program 5: Negative Resist on Silicon Dioxide

Accurate measurements of negative resist on silicon dioxide requires accurate entry of the underlying silicon dioxide thickness. An error in underlayer thickness could result in an error in the measured negative resist thickness.

For assistance in determining the degree of accuracy required for the underlayer thickness value, call the Nanometrics Applications Engineering Department at (408) 746-1600 or (800) 955-6266.

Program 6: Silicon Nitride on Silicon Dioxide

Use this program to measure chemically deposited silicon nitride on silicon dioxide.

Program 11: Positive Resist on Silicon Dioxide

Accurate measurements of positive resist on silicon dioxide requires accurate entry of the underlying silicon dioxide thickness. An error in underlayer thickness could result in an error in the measured positive resist thickness.

For assistance in determining the degree of accuracy required for the underlayer thickness value, call the Nanometrics Applications Engineering Department at (408) 746-1600 or (800) 955-6266.

Program 12: Reflectance Mode

Unlike the film thickness programs, this program measures the amount of light reflected from a sample at up to three user-specified wavelengths. This program can be used to learn the characteristics of a material when defining custom test programs or to monitor before-and-after effects of a process. Use Program 12 with any lens. However, measurements under 380nm requires the UV option with the 15X reflecting lens.

In a process using mercury vapor lamps to expose photolithographic resist, wavelengths of 405, 436, and 546nm should be specified. Mercury vapor produces strong emissions at these wavelengths, and the reflectance of the resist is low since it absorbs light rather than reflecting it.

For incandescent lights, wavelengths of 410, 530, and 650nm might be suitable. Incandescent light emits a continuous spectrum with representative wavelengths in the violet, yellow-green, and red portions of the spectrum.

Measurement time may be varied between 0.1 and 32.7 seconds in steps of 0.1 seconds. Longer times can be used at any wavelength but are particularly recommended when measuring wavelengths below 400nm. Repeatability is substantially improved when measurement times are longer than 3 seconds.

If reflectance measurements are questionable for any reason, try increasing the standard measurement time of 2.5 seconds. For example, if one or more wavelengths is 400nm or less, the accuracy of the measurement may be reduced due to the low signal-to-noise ratio at short wavelengths.

NANOMETRICS

SEMI EQUIPMENT
COMMUNICATIONS STANDARD
SECS II

Model 3000/5000/6000

Data Specifications

Disclaimer

NANOMETRICS makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of suitability must be made by the user in each case.

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The standards set forth herein are subject to change without notice.

1. Introduction

This document describes the SECS interface provided on SEMI E4-91.

Communication: SECS – I (RS232C)
Connector: DB25 (Female)
Master/Slave: Equipment is Master
Duplicated block: Option

Pin No.	RS-232-C	Description
1	AA	Shield
2	BA	Data from Equipment (TX Data)
3	BB	Data to Equipment (RX Data)
4		RTS (from Equipment)[a]
5		CTS (to Equipment)[a]
6		DSR (to Equipment)[a]
7	AB	Ground Signal
20		DTR (from Equipment)[a]

a. This is not required by SECS.

Symbol	Parameter Name	Typical	Range	Resolution
BAUD	Baud rate	9600	300–9600	
DEVID	Device ID	——	0–32768	1
T1	Inter Chaqracter Timeout	10 Sec	0.1–10	0.1 Sec
T2	Protocol Timeout	10 Sec	0.2–25	0.2 Sec
T3	Reply Timeout	45 Sec	1–120	1 Sec
T4	Inter Block Timeout	45 Sec	1–120	1 Sec
RTY	Retry Count	3	0–31	1

Stream Function List

S	F	Description	Transfer
1	0	Abort Transaction(S1,F0)	H <-> E
	1	Are You There Request (R)	H <-> E
	2	On Line Data(D)	H <-> E
	3	Selected Equipment Status Request(SSR)	H -> E
	4	Selected Equipment Status Data(SSD)	H <- E
2	0	Abort Transaction(S2,F0)	H <-> E
	17	Date and Time Request(DTR)	H -> E
	18	Date and Time Data(DTD)	H <- E
	25	Loop back Diagnostic Request(LDR)	H <-> E
	26	Loop back Diagnostic Data(LDD)	H <-> E
	31	Date and Time Set Request(DTS)	H -> E
	32	Date and Time Set Request Acknowledge(DTA)	H <- E
	41	Host Command Send(HCS)	H -> E
	42	Host Command Acknowledge(HCA)	H <- E
5	0	Abort Transaction(S5,F0)	H <-> E
	1	Alarm Report Send(ARS)	H <- E
	2	Alarm Report Acknowledge(ARA)	H -> E
6	0	Abort Transaction(S6,F0)	H <-> E
	3	Discrete Variable Data Send(DVS)	H <- E
	4	Discrete Variable Data Acknowledge(DVA)	H -> E
	5	Multi-block Data Send Inquire(MBI)	H <- E
	6	Multi-block Grant(MBG)	H -> E
9	0	Abort Transaction(S9,F0)	H <-> E
	1	Unrecognized Device ID(UDN)	H <- E
	3	Unrecognized Stream Type(USN)	H <- E
	5	Unrecognized Function Type(UFN)	H <- E
	7	Illegal Data(IDN)	H <- E
	9	Transaction Timer Timeout(TTN)	H <- E
	11	Data Too Long(DLN)	H <- E

Stream Function List (Continued)

S	F	Description	Transfer
10	0	Abort Transaction(S10,F0)	H <-> E
	3	Terminal Display, Single(VTN)	H -> E
	4	Terminal Display, Single Acknowledge(VTA)	H <- E
	5	Terminal Display, Multi-block(VMN)	H -> E
	6	Terminal Display, Multi-block Acknowledge(VMA)	H <- E
	9	Broadcast(BCN)	H -> E
	10	Broadcast Acknowledge(BCA)	H <- E

Stream 1 Equipment Status

S1,F0   Abort Transaction   S, H<->E

Description:

> Used in lieu of an expected reply to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

> <HEADER ONLY>

S1,F1   Are You There Request S, H<->E, reply

Description:

> Establish if the Equipment is on line.

Structure:

> <HEADER ONLY>

S1,F2   On Line Data   S, H<->E

Description:

> Data signifying that the equipment is alive.

Structure:

> **for H<-E**
>
> L, 2
>
> > 1. <MDLN> ....ASCII, 6 bytes
> > 2. <SOFTREV>......ASCII, 6 bytes
>
> **for H->E**
>
> L, 0

S1,F3   Selected Equipment Status Request(SSR) S, H->E, reply

Description:

> A request to the equipment to report selected value of its status.

Structure:

> L, n
>
> > 1. <SVID1> Unsigned Integer, 1, *
> >
> > .
> >
> > .
> >
> > .
>
> n. <SVIDn> Unsigned Integer, 1, *

Exception:

> A zero-length list means report all SVIDs.

S1,F4   Selected Equipment Status Data(SSD) S, H<-E

Description:

> The equipment reports the value of each SVID requested in order requested by S1F3. The host remembers the name of values requested. If any VID specified in S1F3 is invalid, the corresponding V in S1F4 has the following error format:
>
> > L, 0

Structure:

    L, n

        1. <SV1> Unsigned Integer, 1, *

        .

        .

        .

        n. <SVn> Unsigned Integer, 1, *

Exception:

    If n=0, no response can be made. A zero-length return for SVi means the SVIDi does not exist.

        SV1 Measurement Status

            0: Ready(Idle)

            1: Busy (Measuring)

            2: Not Ready

            3: except for 0 - 2

        SV2   Auto Focus Status

            0: w/o Hardware

            1: not available

            2: Available

        SV3   Stage Status

            0: w/o Hardware

            1: not available

            2: Available

        SV4   Loader Status

            0: w/o Hardware

            1: not available

            2: Available

Stream 2 Equipment Control and Diagnostics

S2,F0   Abort Transaction   S, H<->E

Description:

Used in lieu of an expected reply to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

<HEADER ONLY>

S2,F17   Date and Time Request   S, H<-E ,reply

Description:

Useful to check equipment time base or for equipment to synchronize with host time base.

Structure:

<HEADER ONLY>

S2,F18   Date and Time Data   S, H->E

Description:

Actual time data.

Structure:

<TIME>..........ASCII, 12 bytes "yymmddhhmmss"

if yy ≥ 90 then year = 19yy else year = 20yy

S2,F25   Loopback Diagnostic Request S, H<->E, reply

Description:

A diagnostic message for checkout of protocol and communication circuits. The binary string sent is echoed back.

Structure:

<ABS>............BINARY,

S2,F26   Loopback Diagnostic Data   S, H<->E

Description:

The Echoed Binary String.

Structure:

<ABS>............BINARY,

S2,F31   Date and Time Set Request   S, H->E ,reply

Description:

Used to synchronize the equipment time with the host time base. The Host Commands the equipment to set its Date and Time base to the specified value.

Structure:

<TIME>..........ASCII, 12 bytes "yymmddhhmmss"

S2,F32   Date and Time Set Request Acknowledge   S, H<-E

Description:

Acknowledge the receipt of time and date.

Structure:

<TIACK>.......... BINARY, 1 byte

0: OK

1: Error, not done

S2,F41   Host Command Send(HCS)   S, H->E, reply

Description:

The host request the equipment perform the specified remote command with the associated parameters.

Structure:

<RCMD> BINARY, 1 byte (ex: 21H, 01H, xxH)

NUMBER	RCMD	Description
2	PP_START	PROCESS START
6	PP_ABORT	PROCESS ABORT

<RCMD> = 6

L,2

    1. <RCMD> BINARY, 1 byte (ex: 21H, 01H, 06H)

    2.L,0

<RCMD> = 2

L,2

    1. <RCMD> BINARY, 1 byte (ex: 21H, 01H, 02H)

    2.L,1

        1.L,2

            1.<CPNAME> ASCII, 9 bytes "RECIPE_NO"

            2.<CPVAL> Unsigned Integer, 2 bytes (ex: A9H, 02H, x(hi), x(low)

S2,F42   Host Command Acknowledge(HCA)   S, H<-E

Description:

Acknowledge Host command or error. If command is not accepted due to one or more invalid parameters
(i.e. HCACK=3),then a list of invalid parameters will be returned containing the parameter name and reason for
being invalid.

Structure:

<HCACK> BINARY, 1 bytes

HCACK	Description
0	Acknowledge, command has been performed.
1	Command does not exist.
2	Cannot perform now.
3	At least one parameter invalid.
4	Not supported.
5	S2,F41 data type error.

\<HCACK\> ≠ 3

      L,2

           1.\<HCACK\> BINARY, 1 byte

           2.L,0

\<HCACK\> = 3

      L,2

           1.\<HCACK\> BINARY, 1 byte

           2.L,1

                1.L,2

                      1.\<CPNAME\> ASCII, 9 bytes "RECIPE_NO"

                      2.\<CPACK\> BINARY, 1 byte

CPACK	Description
1	Invalid parameter (CPNAME). The CPNAME is not a valid parameter for this command.
2	Illegal parameter value (CPVAL).
3	Illegal format for parameter (CPVAL).
4	The Recipe does not exist at equipment.

Stream 5 Exception Reporting

S5,F0   Abort Transaction   S, H<->E

Description:

Used in lieu of an expected reply to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

<HEADER ONLY>

S5,F1   Alarm Report Send(ARS)   S, H<-E, (reply: option)

Description:

This message report a change in or presence of an alarm condition.

Structure:

L, 3

1. <ALCD>..... Alarm Code ,   BINARY 1 byte

2. <ALID>..... Alarm Identification, BINARY 1 byte

3. <ALTX>..... Alarm Text,   ASCII, Max. 40 bytes

<ALCD>..... Alarm Code ,   BINARY 1 byte

BIT8   1 means alarm set, 0 means alarm clear

BIT7-1 is alarm category code

0:   not used

1:    Personal safety

2:    Equipment safety

3:    Parameter control warning

4:    Parameter control error

5:    Irrecoverable error

6:    Equipment status warning

7:    Attention flags

8:    Data Integrity

9-63: Reserved

<ALID>..... Alarm Identification, BINARY 1 byte

<ALTX>..... Alarm Text,   ASCII max. 40 bytes

Alarm list

ALCD	ALID	ALTX	Description
06H	01H	"CALIBRATED"	Reported when the measurement of the Recipe is terminated.
06H	02H	"NEW TEST"	Reported between the measurement termination of Sample and the next measurement.
86H (06H)	03H	"AUTOFOCUS ERROR"	Reported when an error occurs in Auto Focus.
86H (06H)	04H	"AUTO FOCUS ABORTED"	Reported when Auto Focus is aborted.
86H (06H)	05H	"STAGE ERROR"	Reported when an error occurs in Auto Stage.

Alarm list (Continued)

ALCD	ALID	ALTX	Description
86H (06H)	06H	"LOADER ERROR"	Reported when an error occurs in Auto Loader.
86H (06H)	07H	"TURRET ERROR"	Reported when an error occurs in Auto Turret.

Notes:
- In each item, the setting of "Do/Do not" of communication in the setting of the SECS message is available. However, ALID=3, 4 is regarded as one item.
- The error release report of ALID=3 to 7 is communicated when a certain measure is taken on the display screen showing the error (when clicking Release or Acknowledge).
- In ALID=1, 2, no communication of alarm occurrence is done (only release of the alarm status)

S5,F2   Acknowledge of Alarm Report   S, H->E

Description:

Acknowledge or error.

Structure:

<ACKC5>.... Stream 5 Acknowledge Code BINARY 1 byte

0 = Accepted

0 ≠ Error, not Accepted

Stream 6   Data Collection

S6, F0   Abort Transaction   S, H<->E

Description:

Used in lieu of an expected reply to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

<Header only>

S6, F3 Discrete Variable Data Send (DVS) S or M, H<-E, (reply)

Outline:

Sends measured data. For the format of sending data, choice can be made from two types of the Model 5000/6000 series standard and Model 210 (Choose a suitable format considering the Host).

1) S6, F3, S, (H<-E) based on MODEL 210 series, No response

Description:

Can be used when sending data in the format of our company's MODEL 210 series. However, since this device, as compared with MODEL 210, for reason of a major improvement of measurement capability, has some parts in which the specifications are altered, apply utmost care when operating it. And, for reason of limiting the performance of this device, it is basically not recommended to use this format continuously.

Structure:

L,3

    1.<DATAID> Signed Integer, 1, 1

    2.<CEID>   Signed Integer, 1, 1

    3.L,1

        1.L,2

            1.<DSID> ASCII, 6

            2.L,7

                1. L,2

                    1.<DVNAME1> ASCII, 9, "SAMPLE ID"

                    2.<DVVAL1> ASCII, 18,

                2. L,2

                    1.<DVNAME2> ASCII, 9, "FILM TYPE"

                    2.<DVVAL2> Signed Integer, 1,

                3. L,2

                    1.<DVNAME3> ASCII, 14, "OBJECTIVE LENS"

                    2.<DVVAL3> Signed Integer, 1,

                4. L,2

                    1.<DVNAME4> ASCII, 14, "FILM THICKNESS"

                    2.<DVVAL4> Unsigned Integer 2,

                5. L,2

                    1.<DVNAME5> ASCII, 15, "OXIDE THICKNESS"

                    2.<DVVAL5> Unsigned Integer 2,

                6. L,2

                    1.<DVNAME6> ASCII, 16, "REFRACTIVE INDEX"

                    2.<DVVAL6> ASCII, 7,

                7. L,2

                    1.<DVNAME7> ASCII, 14, "DATA INTEGRITY"

2.<DVVAL7> Signed Integer, 1,

Description of each data

1. <DATAID> : Signed Integer, 1 byte,
    1: The value is fixed to 1 (e.g., 65H, 01H, 01H)
2. <CEID>   : Signed Integer, 1 byte,
    1: The value is fixed to 1 (e.g., 65H, 01H, 01H)
3. <DSID>   : A model name is entered as value.
4. <DVNAME1> "SAMPLE ID" and <DVVAL>: A sample ID inputted is entered as value.
5. <DVNAME2> "FILM TYPE" and <DVVAL>: A program number in measurement is entered. What is correspond-
    ing to MODEL 210's file type, in 4000/5000 series, is not supported.
6. <DVNAME3> "OBJECTIVE LENS> and <DVVAL>:

    An objective lens number in measurement is entered. The correspondence between the

    objective lens number and the actual lens is as follows:

    0: 5X. 1: 10X. 2: 15X(UV) 3: 50X. 4: Fiber
7. <DVNAME4> "FILM THICKNESS> and <DVVAL>: When measuring film thickness, the unit is Angstrom, and a
    measured value is entered. When measuring reflective index, a value magnifying, by 100 times, the reflective index
    [%] of the first measurement wave length is entered. (e.g., when a measured value of 100 [%] is obtained, the number
    10000 is entered). For reason of the format limitation (2 byte length Unsigned Integer), the film thickness to be han-
    dled must be within the range of 0 – 65535.
8. <DVNAME5> "OXIDE THICKNESS" and <DVVAL>: While, in MODEL 210, a value of the bedding oxide film
    thickness value is entered, in 4000/5000 series, on the other hand, the bedding film is not limited to oxide film. A
    value of the bedding oxide film thickness value, measured when simultaneously measuring two layer film thickness,
    is entered. (The limitation on the format is the same as that in 7).
9. <DVNAME6> "REFRACTIVE INDEX> and <DVVAL>: In 4500/5000 series, for reason of considering earnestly
    absorption k and refractive index (n, k) wave length dispersion (wave length dependency), and of measuring wave
    length range also being variable, a specific wave length refractive index has basically no meaning. Therefore, this
    item is not supported, then is filled with blank space.
10. <DVNAME7) "DATA INTEGRITY> and <DVVAL>: In 4000/5000 series, this item is not supported. Therefore, this
    value is the fixed value 0, meaning a normal value in MODEL 210.

Notes on using:

When using any data not specifically supported in this device, you cannot apply this format and pay attention to the differ-
ence of the values of FILM TYPE.

 2) Standard style S6,F3 M, H<-E, reply

Description:

Sends data per sample

Structure:

L, 3

1.<DATAID> Signed Integer 1, 1

2.<CEID>   Signed Integer 1, 1

3.L,n+1 (n: number of measuring points)

1.L,2

1.<DSID1> Unsigned Integer, 2, 0

2.L,6

1. L,2

1.<DVNAME1> ASCII, 10, "PROGRAM NO"

2.<DVVAL1> Unsigned Integer, 1,

2. L,2

1.<DVNAME2> ASCII, 9, "SAMPLE ID"

2.<DVVAL2> ASCII, 18,
                        3. L,2

                                    1.<DVNAME3> ASCII, 8, "WAFER ID"
                                    2.<DVVAL3> Unsigned Integer, 1,
                         4. L,2

                                    1.<DVNAME4> ASCII, 7, "SLOT NO"
                                    2.<DVVAL4> Unsigned Integer, 1,
                        5. L,2

                                    1.<DVNAME5> ASCII, 7, "USER ID"
                                    2.<DVVAL5> ASCII, 16,
                        6. L,2

                                    1.<DVNAME6> ASCII, 4, "UNIT"
                                    2.<DVVAL6> ASCII, 3,
***
                        2.L,2
                        1.<DSID2> Unsigned Integer, 2, (1~n)
                        2.L,5
                                    1. L,2

                                                1.<DVNAMEm>   ASCII, 5, "MEAS1"
                                                2.<DVVALm>   ASCII, 10,
                                    2. L,2

                                                1.<DVNAMEm+1> ASCII, 5, "MEAS2"
                                                2.<DVVALm+1> ASCII, 10,
                                    3. L,2

                                                1.<DVNAMEm+2> ASCII, 5, "MEAS3"
                                                2.<DVVALm+2> ASCII, 10,
                                    4. L,2

                                                1.<DVNAMEm+3> ASCII, 4, "XPOS"
                                                2.<DVVALm+3> ASCII, 8,
                                    5. L,2

                                                1.<DVNAMEm+4> ASCII, 4, "YPOS"
                                                2.<DVVALm+4> ASCII, 8,
***
            ================================
            n.L,2
                        1.<DSIDn> Unsigned Integer, 2, n
                        2.L,5
            ================================
Limited only to the number of measuring points, the contents between *** and *** are repeated.

Description of <DATAID> and <CEID>

1. <DATAID> : Signed Integer, 1 byte, 1: the value is fixed to 1 (e.g., 65H, 01H, 01H)
2. <CEID>: Signed Integer, 1 byte, 1: the value is fixed to 1 (e.g., 65H, 01H, 01H) Description of the value (DVVAL) corresponding to each DVNAME
3. "PROGRAM No": Program No. in execution. A value in the range of (1 to 200) is entered.
4. "SAMPLE ID": Current SAMPLE ID.
5. "WAFER ID": Number indicating the cardinal number of samples in measurement after program start-up. In the case of a device with loader, the number increases per Wafer. In the other cases, the number increases per NEW TEST.

6. "SLOT NO": A value of the slot number of Wafer cassette in a device with loader. This value is valid only when the loader is in function. When it is invalid, "0" is entered.

7. "USER ID": The ID of the user currently logged on (or currently operating) is entered.

8. "UNIT": Indicates units of measured values of film thickness (reflective index):

    "%": reflective index

    "um": micron

    "nm": nanometer

    "Ang": Angstrom

9. "MEAS1" : Means an upper layer film thickness value or a reflective index value of the firstmeasurement wavelength.

10. "MEAS2": Means a lower layer film thickness value when simultaneously measuring two layer film, or the second wave length reflective index value when measuring reflective index of two wavelengths or over. If no data exists, it is filled with blank space.

11. "MEAS3": If there exists no value of FIT when measuring film thickness, or no data effective as data when measuring reflective index of 3 wave lengths, it is filled with blank space.

12. "XPOS" and "YPOS": A sample coordinate is entered only in a device equipped with Auto Stage, in the status of this Auto Stage being functioning. If invalid, it is filled with blank space.

Note: "MEAN1","MEAN2","MEAN3" may have other type of measurement as shown in examples below.

"Min @": wavelength at minimum reflectance, unit:[nm] (scan measure)

"Max @": wavelength at maximum reflectance, unit:[nm] (scan measure)

"Min %": minimum reflectance, unit:[%] (scan measure)

"Max %": maximum reflectance, unit:[%] (scan measure)

"Mean%": mean reflectance, unit:[%] (scan measure)

"N/A ": not available

S6, F4 Discrete Variable Data Acknowledge S, H->E

Description:

Acknowledge response of S6, F3. The specifications ignore the contents of the response.

Structure:

<ACKC6>

S6, F5 Multi-block Data Send Inquire   S, H<-E, reply

Description:

Message to obtain the Host's permission prior to do multi-block send to the Host in Stream 6.

Structure:

L. 2

1. <DATAID> BINARY. 1 BYTE
2. <DATALENGTH> Unsigned Long 4 Bytes (BIH, 04H)

S6, F6 Multi-block Grant S, H->E

Description:

Permission grant of S6, F5.

Structure:

<GRANT6>...BINARY 1 BYTE

0: Send grant

1: Busy, Retry request

2: Not wanted

>2: Other errors (The specifications treat them as in 1)

Stream 9 System Errors

<MHEAD>: BINARY, 10 bytes SECS message block header associated with message block in error.
<SHEAD>: BINARY, 10 bytes Stored Header

S9,F0   Abort Transaction   S, H<->E

Description:

Used in lieu of an expected reply to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

<HEADER ONLY>

S9,F1   Unrecognized Device ID   S, H<-E

Description:

The device ID in the message block header did not correspond to any known device ID in the node detection the error.

Structure:

<MHEAD>

S9,F3   Unrecognized Stream Type   S, H<-E

Description:

The equipment does not recognize the stream type in the message block header.

Structure:

<MHEAD>

S9,F5   Unrecognized Function Type S, H<-E

Description:

This message indicates that the function in the message ID is not recognized by the receiver.

Structure:

<MHEAD>

S9,F7   Illegal Data   S, H<-E

Description:

This message indicates that the stream and function were recognized but the associated data format could not be interpreted.

Structure:

<MHEAD>

S9,F9   Transaction Timer Timeout S, H<-E

Description:

This message indicates that a transaction(receive)timer has timed out and that the corresponding transaction has been aborted.

Structure:

<SHEAD>

S9,F11 Data Too Long   S, H<-E

Description:

This message to the host indicates that the equipment has been sent more data than it can handle.

Structure:

<MHEAD>

Stream 10 Terminal Services

1. \<TID\>........Terminal ID   BINARY, 1 byte, Terminal number

      0 = Single or main terminal

      0 ≠ Additional terminals at the same equipment (not supporte)

2. \<TEXT\>.......A Single line of characters. ASCII, n (max. 72)

3. \<ACKC10\>.....Stream 10 Acknowledge Code BINARY, 1

      0 = Accepted for display

      1 = Message will not be display

      2 = Terminal not available

      3-63: Reserved

S10,F0   Abort Transaction   S, H<->E

Description:

    Used in lieu of an expected reply to abort a transaction.

    Function 0 is defined in every stream and has the same meaning in every stream.

Structure:

    \<HEADER ONLY\>

S10,F3   Terminal Display Single S, H->E, reply

Description:

    Data to be display.

Structure:

    L, 2

        1. \<TID\> BINARY, 1, 0

        2. \<TEXT\> ASCII, n (n ≤ 72)

S10,F4   Terminal Display Single Acknowledge S, H<-E

Description:

    Acknowledge or error.

Structure:

    \<ACKC10\>   BINARY, 1

S10,F5   Terminal Display Multi-block M, H->E, reply

Description:

    Data to be display on the equipment's terminal.

Structure:

    L, 2

        1. \<TID\> BINARY, 1, 0

        2. L, Ln

            1. \<TEXT\> ASCII, n1 (n1 ≤ 72)

            2. \<TEXT\> ASCII, n2 (n2 ≤ 72)

            :

        Ln.\<TEXT\> ASCII, nLn(nLn ≤ 72)

S10,F6   Terminal Display Multi-block Acknowledge S, H<-E

Description:

Acknowledge or error.

Structure:

<ACKC10>   BINARY, 1

S10,F9   Broadcast S, H->E, reply

Description:

Same S10F3.

Structure:

<TEXT> ASCII, n (n ≤ 72)

S10,F10 Broadcast Acknowledge S, H<-E

Description:

Acknowledge or error.

Structure:

<ACKC10>   BINARY, 1