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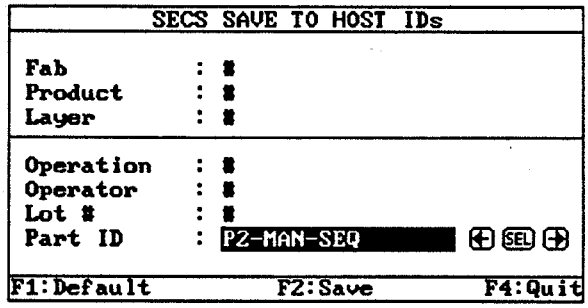


Figure 10-18 Uploading Sequence Data

Enter values for the IDs and press [F2: Save] to upload the data.

If Save is set to Off and the SECS option is set to upload data manually, you can upload the data from the Data screen.

9. If Export is on, the Export Filename window is displayed (Fig. 10-19). (Note: If Save is Off, the Database Save IDs window is displayed, allowing you to set the seven-level ID structure for exporting data.)

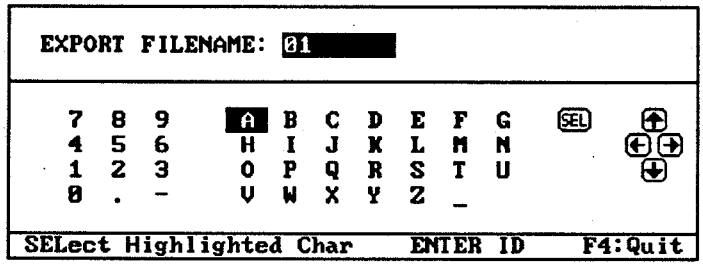


Figure 10-19 Export Filename Window

Note: The Export function is different than the SECS Upload function.

- The filename from the Database Sequence IDs window is displayed. If you are automatically assigning the data filenames, then the export file will be assigned the same name.
- Press ENTER to export the data.

10. If Deskew is Off, go to step 12.
11. **If Deskew is On:**

The sample stage moves near to the Deskew1 location, and the Motion screen (Fig. 10-13) is displayed with the message:

Adjust Deskew Reference 1. Press ENTER When Ready.

Use the trackball or arrow keys to reposition the sample, thus correcting the translational (X-Y) error. Theta is not functional for the two deskew points;

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therefore, the stage can be moved in the X-Y direction only. Press ENTER when done. The stage automatically moves to the Deskew2 position, and the following message is displayed:

Adjust Deskew Reference 2. Press ENTER When Ready.

Reposition the sample and press ENTER. All subsequent locations in the sequence will be referenced to these two points.

NOTE:	When setting precise locations, especially in a sequence, it is important that the camera is at maximum zoom, and the stylus is nulled on the surface of the sample. Press zϴ until the stylus has clearly come into contact with the surface. Do not rely on the appearance of the image, but use the Z coordinate reading to verify that the stylus is in contact with the surface. Press and release the [↓] key until the displayed Z coordinate does not change. Setting locations while at intermediate zoom settings and/or with the stylus not in contact with the sample surface can introduce imprecision in the true stylus location on subsequent scans.

Note: To abort the deskew operation and return to the Sequence Program screen, press STOP.

If Deskew is With Theta:

NOTE:	Programmed theta coordinates are not functional in Deskew With Theta in the Automatic mode. To use programmed theta coordinates, run the sequence without deskew. Also note that when running a sequence in Automatic mode, the programmed theta information is displayed only when deskew is off.

The sample stage automatically goes to the first two deskew points as described above. After you have repositioned the sample at Deskew2, the rotational error is calculated and corrected with the theta motor.

After the sample is rotated, Deskew2 might be slightly offset in the X-Y direction. Reposition the sample once again to correct for this error.

12. When the sequence is started, the screen lists each location number in the sequence and the parameter to be displayed. Only one parameter per recipe is shown, and is the first parameter (as you go down the list in the Scan recipe) programmed for Display.

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NOTE: **You can press STOP to abort the sequence at any time. To resume the sequence, press START. If you are using the wafer handler or if the instrument locks up, see Section 10.5.4, "Stopping and Resuming a Sequence," for details on resuming sequences.**

The Scan screen is displayed while the scan is in progress. When the first scan is complete, a Data screen is displayed similar to the one shown below:

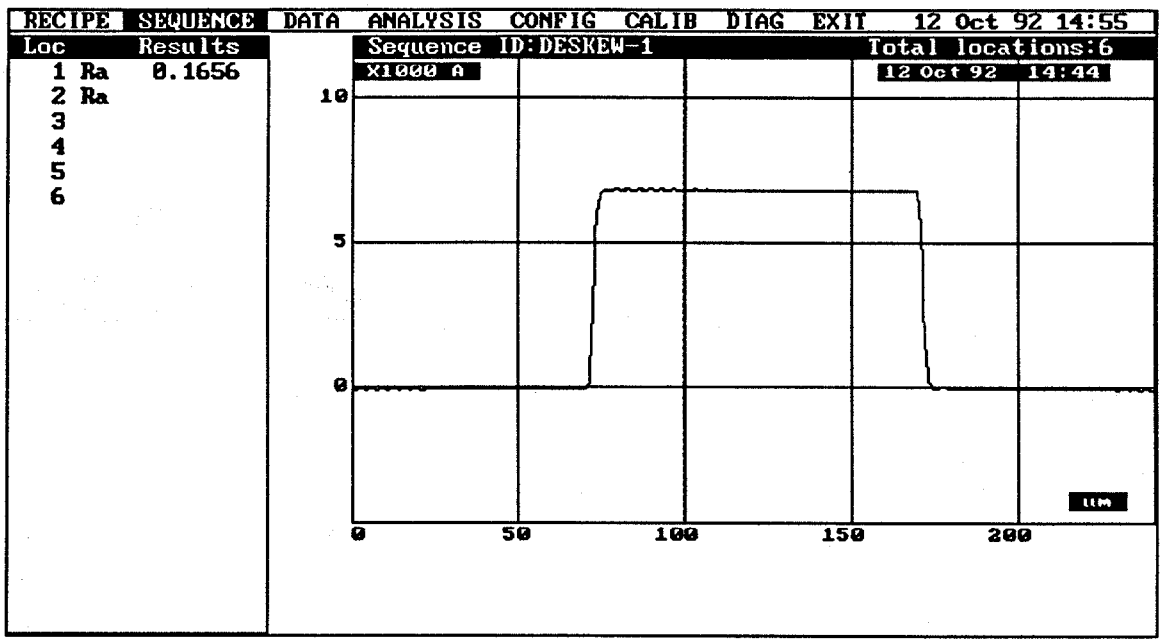


Figure 10-20 Data Screen in Sequence Mode

The Graph box displays the trace, the Sequence ID, and the total number of locations to be scanned. The Summary box contains the location numbers, the parameters selected for display (one per recipe), and the results for each parameter.

The stylus automatically moves to the next location, and the process is repeated. When the sequence is completed the final Data screen is displayed (Fig. 10-21).

If the Print option is On, the results are printed automatically.

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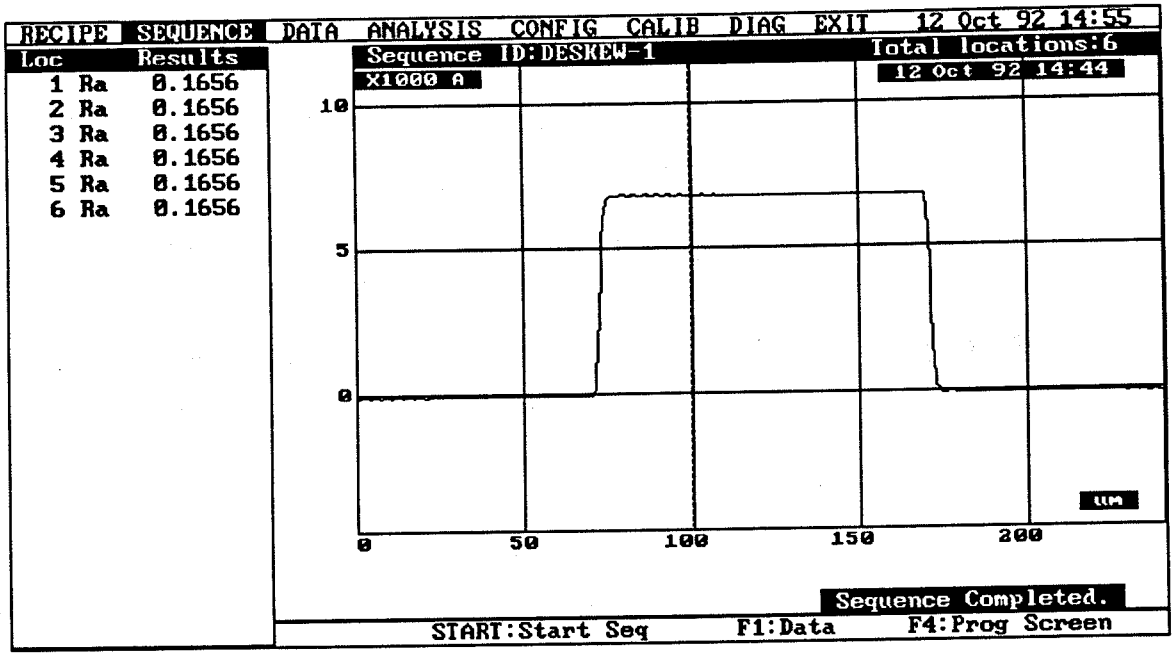


Figure 10-21 Data Screen After Sequence Completion

13. The stage moves to the load position:

    - If you are loading and unloading samples manually, unload the sample. If the Sort option is set to On, the pass or fail status of the sample is displayed on the screen.

    - If you are running a cassette of wafers with the Sort option set to separate passed and failed wafers, the wafer handler unloads passed and failed wafers to separate cassettes. The status of each wafer is displayed in the Select Cassette Slots window (Fig. 10-8).

14. Before the next sample is loaded:

    - If the Save option is On, you are prompted only for the Save filename if the filename is not set to be automatically assigned. If you have set the filename to be assigned automatically, you will not be prompted for the Save filename. The SECS Save IDs window is displayed only when the first wafer is loaded. For subsequent wafers, the data is uploaded with the same name entered for the Save option. You will always be prompted for the export filename for each wafer.

    - If the Save option is Off and the SECS and Export options are On, you will be prompted for the SECS Save IDs window and the Export Filename window before each wafer is loaded.

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10.5.4 STOPPING AND RESUMING A SEQUENCE

These procedures apply only if you are loading and unloading wafers using the handler. To resume a stopped sequence on a sample other that a wafer, press START.

If you press STOP during loading or unloading of wafers:

1. The Handler Load (Fig. 6-12) or Handler Unload window (Fig. 6-31) is displayed to allow you to continue the interrupted operation.
2. Press START to complete the interrupted operation and continue with the sequence, or press [F4: Quit] to abort the sequence.

If the instrument locks up during a sequence:

1. Press RESET to reset the instrument and wafer handler.
2. Reload the same sequence that was being run when the instrument locked up. The following prompt is displayed:

   Load cassette data file to resume sequence? [Y/N]

3. Press YES to resume the sequence at the same wafer at the time of lockup, or press NO to begin the sequence again at first selected wafer.

> **CAUTION:** **Before pressing YES to resume the operation, make sure the wafers and cassettes are in the same location as before the lockup; otherwise, the wafers could be damaged.**

10.6 RUNNING A SEQUENCE IN MANUAL MODE

The Manual mode functions like Automatic mode except that at each location the scan, data analysis, and data storage are under manual control. This mode allows rescanning, if necessary, or experimenting with different analyses.

When you start a sequence in Manual mode, the sequence stops at each location and allows you to adjust the X-Y location for precise positioning before the measurement is taken. The sequence also stops after each scan enabling analysis and storage of the data.

> **NOTE:** **You cannot change a Sequence program in this mode. See Section 10.4, "Setting up a Sequence Program," for details.**

To run a sequence in Manual mode:

1. If you want to upload sequence data to the host computer, you must enable and set the SECS Option to upload data before running a sequence program. See Section 6.14, "Setting the SECS Interface Option to Upload Data," for details.
2. Press MENU.

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3. Choose either View/Modify, Recall, or Catalog from the Sequence menu to display the desired Sequence program (Fig. 10-1).

   - If the sequence has not yet been programmed to Manual, use [↓] to select the Mode field. Then use [←] or [→] to toggle to Manual.
   - If you do not want to start the sequence at location #1, press [F4: Toggle Field] and use [↑] or [↓] to highlight the location at which you want to begin.
   - To adjust the Deskew reference location, with Deskew set to On press [F4: Toggle Field] and use [↑] or [↓] to highlight either deskew value.
   - To view a Scan recipe, highlight the name and press [F1: Recipe]. You can change the recipe contents in Setup mode only and the keylock must be set to position 3. You cannot change Scan recipe IDs or coordinate values in Manual mode.

4. Load the sample. If you are manually loading the sample, see Section 6.3.1, "Loading a Sample Manually," for details. If you are using the wafer handler to load a wafer, see Section 6.3.2, "Loading Single Wafers Using the Wafer Handler," for details. Note: You cannot use the Select or Random Cassette options in Manual mode.

5. Press START. If the Deskew reference was not selected in Step 3, go to step 6. If Deskew is On and selected:

   The sample stage moves to the Deskew1 location, and the Motion screen (Fig. 10-13) is displayed with the message:

   Adjust Deskew Reference 1. Press ENTER When Ready.

   Use the trackball or arrow keys to reposition the sample, thus correcting the translational (X-Y) error. Theta is not functional for the two deskew points; therefore, you can move the stage in the X-Y direction only. Press ENTER when done. The stage automatically moves to the Deskew2 position, and the following message is displayed:

   Adjust Deskew Reference 2. Press ENTER When Ready.

   Reposition the sample and press ENTER. All subsequent locations in the sequence will be referenced to these two points. After the Deskew operation, the Sequence Program screen is displayed.

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NOTE: **When setting precise locations, especially in a sequence, it is important that the camera is at maximum zoom, and the stylus is nulled on the surface of the sample.**

Press zθ until the stylus has clearly come into contact with the surface. Do not rely on the appearance of the image, but use the Z coordinate reading to verify that the stylus is in contact with the surface. Press and release the [↓] key until the displayed Z coordinate does not change.

Setting locations while at intermediate zoom settings and/or with the stylus not in contact with the sample surface can introduce imprecision in the true stylus location on subsequent scans.

To abort the deskew operation and return to the Sequence Program screen, press STOP.

If Deskew is WITH THETA:

Reposition the first two deskew points as described above. After you have repositioned the sample at Deskew2, the rotational error will be calculated and corrected with the theta motor.

After the sample is rotated, Deskew2 might be slightly offset in the X-Y direction. Reposition the sample again to correct for this error.

The Sequence Program screen is displayed again. Select the first location to be scanned and press START.

6. The Motion screen corresponding to the selected sequence location number is displayed (Fig. 10-22). Press START again.

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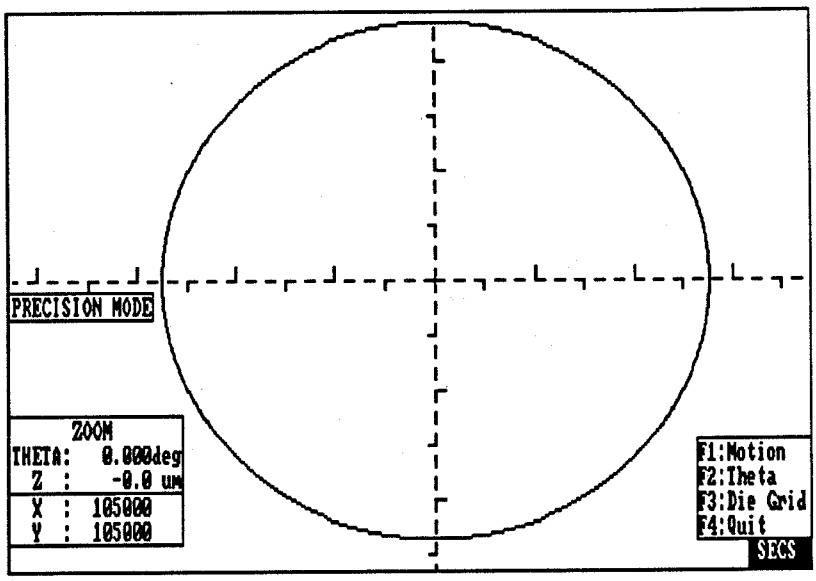


Figure 10-22 Motion Screen

7. If the Save option is On, the Sequence IDs window is displayed:

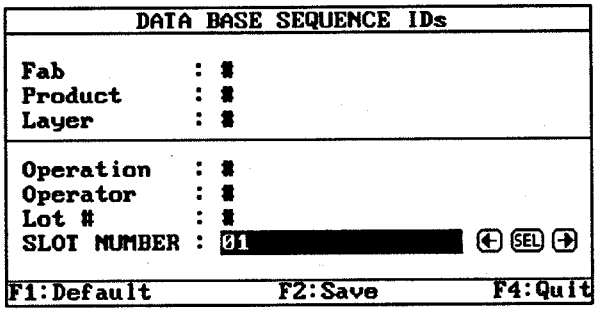


Figure 10-23 Sequence IDs Window

- The first three IDs have the same values entered in the Sequence program. Do not change these values. You can enter values for the next four IDs.
- Enter a filename in the last ID. You do not have the option of automatically assigning filenames in Manual mode.
- When you save data in Manual mode at a given location, it replaces the last data saved at that location.

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> **NOTE:** If Save is set to Off, you can save individual traces only when the Data screen is displayed at the end of each scan. You also can upload data, using the SECS Interface Option, from the Data screen. However, you cannot use the Export option in Manual mode.

8. If Save is set to On and the SECS option is set to upload data automatically, you are prompted to upload data. Data is automatically uploaded using the IDs entered in the Database Sequence IDs window.

   If Save is set to Off and the SECS option is set to upload data automatically, the Save SECS IDs window is displayed (Fig. 10-18). Enter values for the IDs and press [F2: Save] to upload the data.

   If Save is set to Off and the SECS option is set to upload data manually, you can upload the data from the Data screen. See step 10 below for details.

9. The sequence starts, the screen displays the Scan screen followed by the Data screen (Fig. 10-24) when the scan is complete. To print the results, press PRINT after each trace is displayed.

   You can press STOP to abort the sequence and return to the Sequence Program screen at any time.

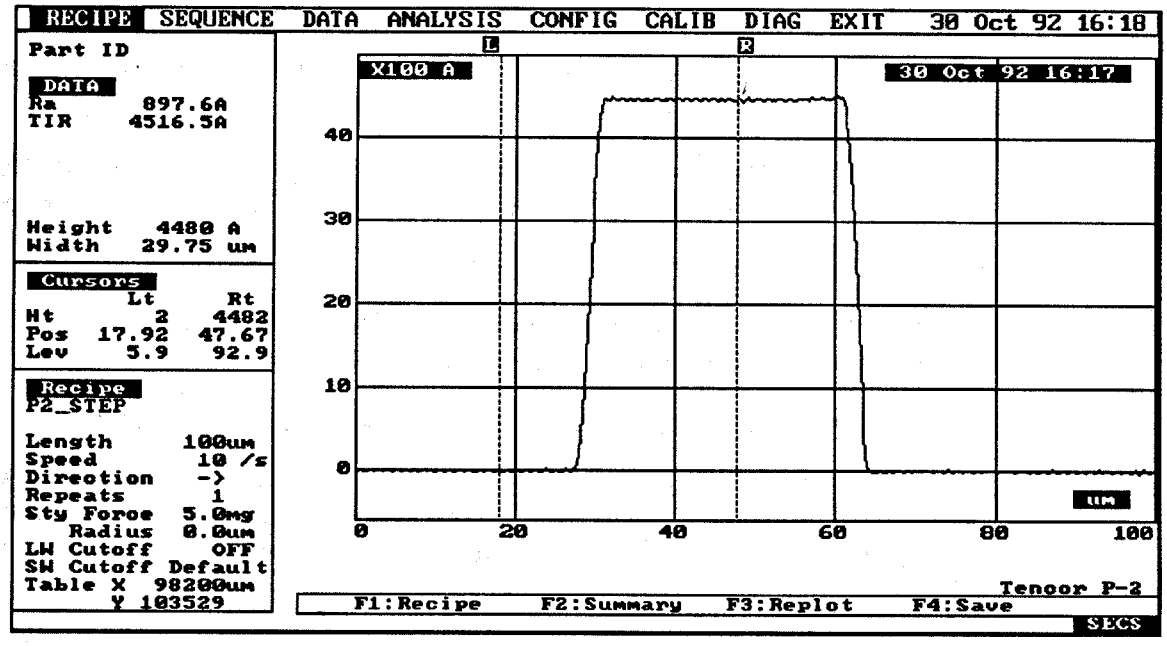


Figure 10-24 Data Screen

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10. To save sequence data or to upload data manually to the host computer, press [F4: Save]. The following window is displayed:

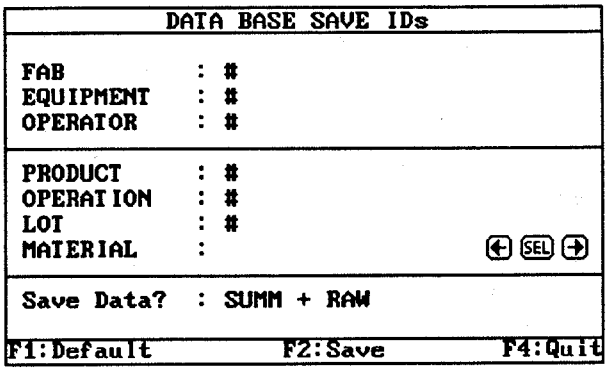


Figure 10-25 Database Save IDs Window

To save the data:

CAUTION: Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."

- The first three IDs have the same values entered in the Sequence program. Do not change these values.
- Select values for the remaining IDs and press [F2: Save] to save the data. The SECS Save IDs window (Fig. 10-18) is displayed if the SECS option is enabled.

To upload the data without saving the data:

- Press [F4: Quit] to exit the Database Save IDs window without saving the data. The SECS Save IDs window (Fig. 10-18) is displayed.
- Select values for the IDs and press [F2: Save] to upload the data.

11. Press MENU to return to the Sequence Program screen. To scan the next location, press START to display the Motion screen. Press [F2: Next] to move the stylus to the next location. Then press START to initiate the scan.

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10.7 DISPLAYING DATA

Sequence data can be displayed as trace data (Fig. 10-24), summary data from an individual trace (Fig. 10-29), or statistics and point data (Figs. 10-31 and 10-32).

You can display sequence data from the following menu items or screens:

- Recall from the Data menu
- Catalog from the Data menu
- The Data screen displayed at the end of a sequence run in Automatic mode (Fig. 10-21)

10.7.1 ACCESSING DATA VIA THE DATABASE CATALOG

To access data via the Database catalog:

1. Press MENU.
2. Choose Catalog from the Data menu and press ENTER. The following window is displayed:

```
DATA BASE RECALL IDs

FAB          : *                    ← SEL →
EQUIPMENT    : *
OPERATOR     : *

PRODUCT      : *
OPERATION    : *
LOT          : *
MATERIAL     : *

Recipe ID    : *
Sequence ID  : *
Type         : Any Data
Begin Time   : -- --- ----  --:--
End Time     : -- --- ----  --:--

F1:Default  F2:Recall  F4:Quit
```

Figure 10-26 Database Recall IDs Window

3. Use [↑] or [↓] to move between the IDs.
   - Use [←] or [→] to select available values for the IDs.
   - If the data was saved using the default value (#), press [F1: Default] to enter # as an identifier in the first seven IDs (Fab, Equipment, Operator, Product, Operation, Lot, and Material in Fig. 10-26). See Section 12.3, "Operating the Database," for more information on default values.

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- Entering values for Type, Begin Time, and End Time is optional. These three categories are useful if you have a very large amount of data in the database and if you know the time frame during which the data was saved.
- To display the entire database, enter * in all the IDs, except Type, Begin Time, and End Time.

See Section 12.3.3, "Recalling Data," for more information on recalling data using assigned values and default values.

4. Press [F2: Recall] to display the Database catalog:

SELECTION DATA CATALOG

SLOT NUMBER	Item Type	Recipe ID	Sequence ID	Date	Time
25	Seq Results		QUICKY	30 Jun 92	11:17:44
25	Seq Results		QUICKY	30 Jun 92	10:36:33
XXXX	Seq Results		QUICKY	30 Jun 92	11:36:22
XXXX	Seq Results		QUICKY	30 Jun 92	11:24:21
XXXX	Seq Results		QUICKY	30 Jun 92	11:13:02
1	Seq Results		SQRCP3	11 Jun 92	16:51:22
10	Seq Results		SQRCP3	11 Jun 92	17:13:29
11	Seq Results		SQRCP3	11 Jun 92	17:15:56
12	Seq Results		SQRCP3	11 Jun 92	17:18:23
13	Seq Results		SQRCP3	11 Jun 92	17:20:50
14	Seq Results		SQRCP3	11 Jun 92	17:23:19
15	Seq Results		SQRCP3	11 Jun 92	17:25:46
16	Seq Results		SQRCP3	11 Jun 92	17:28:12
17	Seq Results		SQRCP3	11 Jun 92	17:30:40
18	Seq Results		SQRCP3	11 Jun 92	17:33:09
19	Seq Results		SQRCP3	11 Jun 92	17:35:36

Fab : # Operation : TEST
Product : # Operator : KC
Layer : # Lot # : A

CLEAR F1:Select F2:View F3:Combine F4:Quit

Figure 10-27 Database Catalog

5. Use [←] or [→] to select a filename and press [F2: View] to display the Sequence Data screen (Fig. 10-28):

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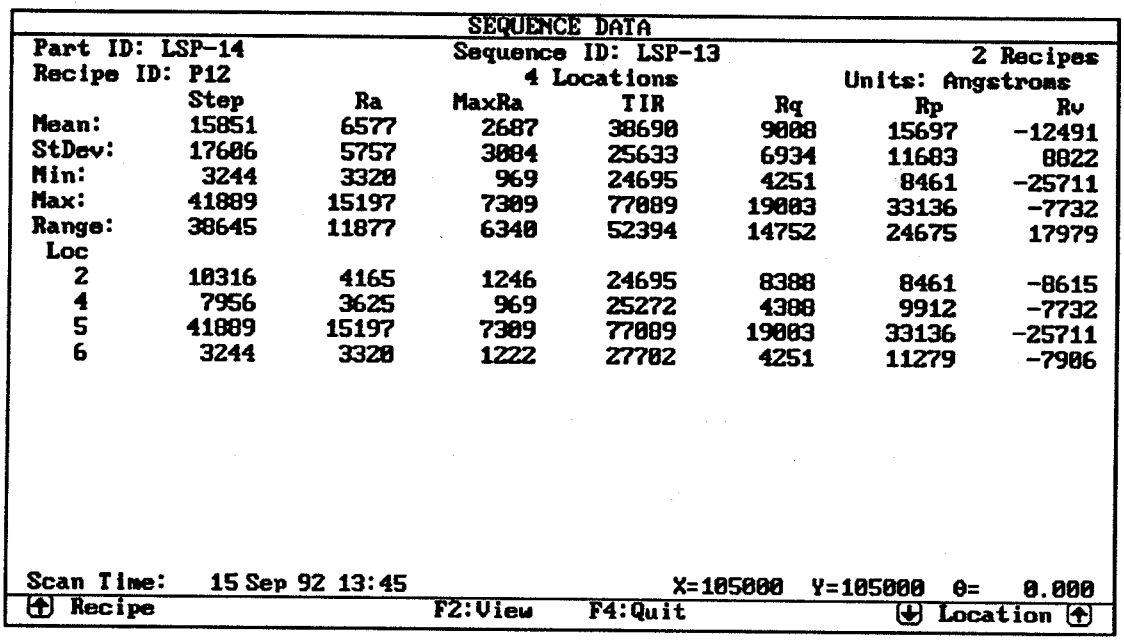


Figure 10-28 Sequence Data Screen

The Sequence Data screen displays the following information grouped by Scan recipes:

- Statistics for each parameter selected
- Point Data (parameter values) at each scan location
- Part, Sequence, and Recipe IDs
- The number of locations scanned with a given Scan recipe
- The total number of Scan recipes used in the sequence

Statistics displayed are the mean, standard deviation, minimum, maximum, and range for each parameter selected. Statistics are calculated for scans taken using the same Scan recipe.

> **NOTE:** **There always must be at least two scans with the same recipe for statistics to be displayed.**

Point Data (parameter values) shown are those chosen for display in the Scan recipe and those chosen to be saved but not displayed. A maximum of seven parameters are shown, including Step, which is always displayed.

If more than one Scan recipe was used in the sequence, press [↑] or [↓] to display data collected with a different Scan recipe. Note the arrow prompt in the lower left corner of the screen.

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When the Recipe ID changes, the statistics and number of locations change as well.

Press [↑] or [↓] to highlight data taken at another scan location. The arrow(s) in the lower right corner of the screen indicates which arrow to press to access another location.

Note that as a new scan location is selected, the scan time and X, Y, and theta coordinates change. Scan time is the date and time that the scan was taken. X, Y, and theta are the coordinates of the scan location.

All parameter units are in Angstroms or microinches, depending on which units were selected in the Scan recipe.

- Press [F2: View] to display the Summary screen (Fig. 10-29) for the selected scan location if the Point Data save option was selected; to display the Data screen if the Trace Data save option was selected.
- Press [F4: Quit] to return to the Sequence Data screen.
- Press [F4: Quit] from the Sequence Data screen to return to the screen from which it was originally called, i.e., Sequence Program screen, Data catalog, or menu bar.

```
SCAN SUMMARY DATA      Part ID:  123                    15 Oct 92  17:05

RECIPE                 CURSORS                DATA
ID:          P2-S                             Ra [Average]   :     955A
                       Height    :   -868A     max Ra         :     884
Length   :   500um     Left      :  -1829     Rq[RMS]        :    1187
Speed    :    10um/s   Right     :  -2697     Rp [Peak]      :    2128
Time     :     50s                            Rv [Valley]    :   -3105
Horiz.Res :   0.2um    Width     :  99.77um   Rt [P/V]       :    5233
Sty Force :  15.0mg    Left      :   0.00     Rz[10pt height]:    4276
Sty Drop  :      3     Right     :  99.77     R3z[6pt height]:    4945
Sty Radius:  12.5um    L.delta   :      0     Wa [Average]   :      94
Direction :      ->    R.delta   :      0     TIR            :    5397
V.Range:  13um/520uin
Repeats   :      1     Leveling  :
Cutoff  : 0.08mm/3mil  Left      :    10um
                       Right     :    400
                       L.delta   :      0
                       R.delta   :      0     Cursors
                                              Height    :   -868A
                                              Width     :  99.77um
                                                          F4: Quit
```

Figure 10-29 Summary Screen

10.7.2 ACCESSING DATA AFTER RUNNING A SEQUENCE

After a sequence is run in Automatic mode, the stage returns to the load position and the final Data screen is displayed (Fig. 10-21). Press [F1: Data] to display the Sequence Data screen (Fig. 10-28).

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10.8 PRINTING DATA

There are two methods available for printing sequence data. One method enables you to print data after the completion of the sequence by retrieving it by its Part ID, whereas the other method prints the data automatically while the sequence is running. This section provides information on printing data after completion of the sequence only; to print automatically while the sequence is running, see the Print option described in Section 10.3.2, "Sequence Fields."

To print after completion of the sequence:

1. From the Sequence Program screen, press PRINT on the built-in keyboard or PRINT SCREEN (*not* SHIFT + PRINT SCREEN) on the remote keyboard to print the current sequence data on a compatible black and white or color printer. The following window is displayed:

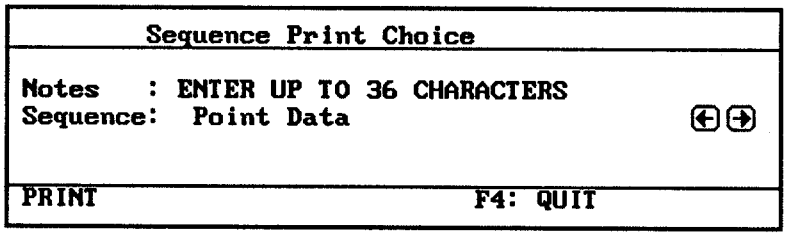


Figure 10-30 Printing Sequence Data

2. If desired, enter a comment such as a description of the sample or an explanation of the data. The note can be a maximum of 36 characters.
3. In the Sequence field, press [←] or [→] to select the type of data to be printed (Sequence Program, Point Data, or Statistics). When Point Data is selected, both point data and statistics are printed. When Statistics is selected, only statistics are printed.
4. Press PRINT or PRINT SCREEN to initiate printing or [F4: Quit] to abort the operation. See Fig. 10-31 and Fig. 10-32, respectively, for sample printouts of Summary Statistics and Point Data and Statistics.

   To print out data for individual scans (Trace and Point data):

   - Press MENU.
   - Choose Catalog from the Data menu.
   - Use [↑] and [↓] to select the sequence results for printing.
   - In the sequence Data screen, press F2 to view each individual trace, then PRINT or PRINT SCREEN to print the data.

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Data ID: 2716
Notes: Correlation data
Sequence ID: TEST-1

Recipe: TEST Unit: Angstroms No. of Locations: 4

	Step	Ra	Rq	Rp	Rv
Mean:	15851	6576	9007	15696	12491
S.D.	17605	5757	6934	11682	8821
Min	3244	3320	4250	8460	-25711
Max	41889	15196	19002	33135	-7732
Range	38645	11876	14752	24675	17979

Figure 10-31 Sample Printout of Summary Statistics

Data ID: 2716
Notes: Correlation data
Sequence ID: TEST-1

Recipe: TEST Unit: Angstroms No. of Locations: 4

	Step	Ra	Rq	Rp	Rv
Mean:	15851	6576	9007	15696	12491
S.D.	17605	5757	6934	11682	8821
Min	3244	3320	4250	8460	-25711
Max	41889	15196	19002	33135	-7732
Range	3865	11876	14752	24675	17979
Loc					
2	10316	4165	8388	8460	-8615
4	7956	3624	4388	9912	-7732
5	41889	15196	19002	33135	-25711
6	3244	3320	4250	11279	-7906

Figure 10-32 Sample Printout of Point Data and Statistics

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10.9 MAINTAINING SEQUENCE PROGRAMS

Sequence programs can be exported, deleted, imported, backed up, and restored. The Export and Delete functions are accessed in the Sequence catalog. To import, back up, and restore Sequence programs, use the Maintain option listed in the Sequence menu on the menu bar.

10.9.1 DELETING SEQUENCE PROGRAMS

To delete a Sequence program:

1. Press MENU one or more times until the menu bar is displayed and active.
2. Choose Catalog from the Sequence menu and press ENTER to display the Sequence catalog:

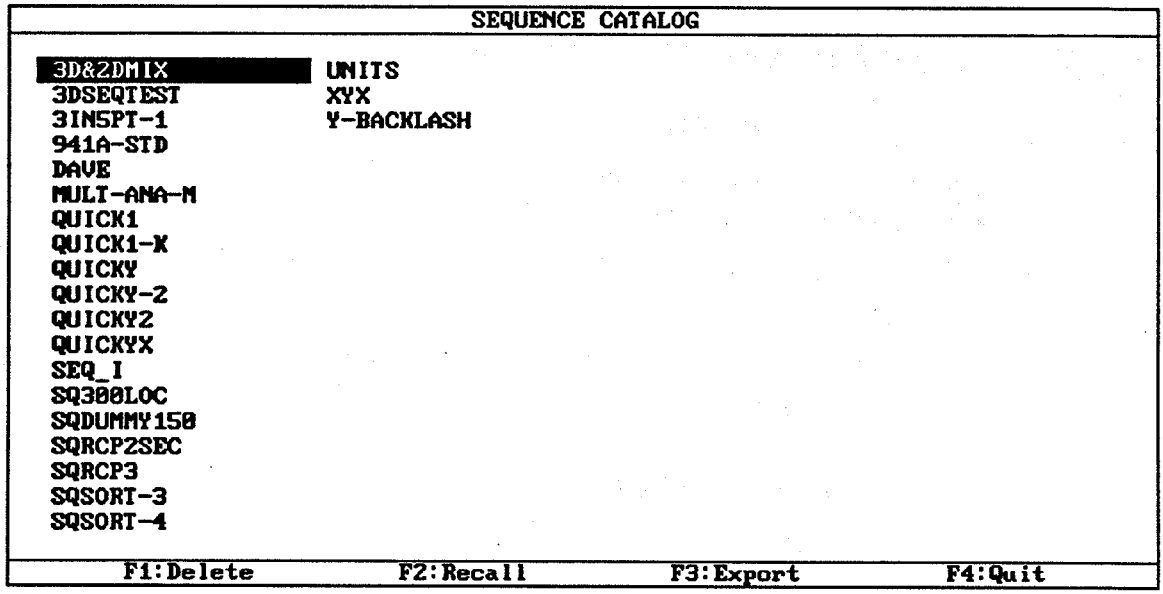


Figure 10-33 Sequence Catalog

3. Press [↑] or [↓] to select a Sequence program.
4. Press [F1: Delete] to delete the selected Sequence program. Note: You cannot delete Sequence programs that were used to generate data and the data was saved. To delete such Sequence programs, first delete the data and then the programs.
5. Press [F4: Quit] to exit the catalog.

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10.9.2 EXPORTING SEQUENCE PROGRAMS

To export a Sequence program:

1. Press MENU one or more times until the menu bar is displayed and active.
2. Choose Catalog from the Sequence menu and press ENTER to display the Sequence catalog (Fig. 10-33).
3. Press [↑] or [↓] to select a Sequence program.
4. Press [F3: Export] to export the selected Sequence program. Note: Before you export the selected Sequence program, make sure the disk path is set correctly. Check that there is a blank, formatted diskette in drive A if you plan to export the Sequence program to drive A. See Section 7.9, "Saving Data and Recipes," for details on setting the disk path.
5. Press [F4: Quit] to exit the catalog.

10.9.3 IMPORTING SEQUENCE PROGRAMS

To import Sequence programs:

1. Change the disk path if necessary. See Section 7.9, "Saving Data and Recipes," for procedures on changing the disk path.
2. From any screen, press MENU one or more times until the menu bar is displayed and active.
3. Choose Maintain from the Sequence menu and press ENTER to display the Sequence Maintenance window:

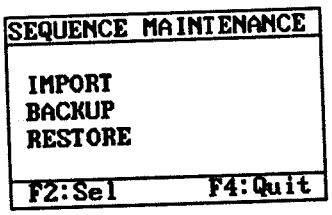


Figure 10-34 Sequence Maintenance Menu

4. Choose Import and press ENTER or [F2: Sel]. You are prompted to enter the import filename (Fig. 10-35).

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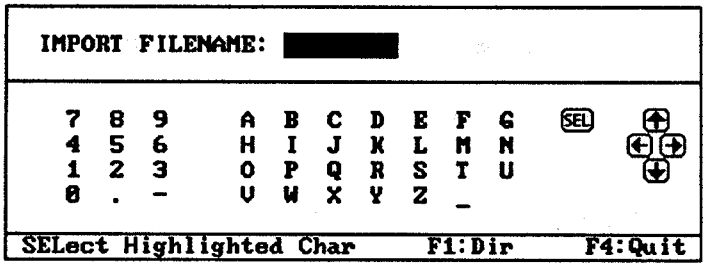


Figure 10-35 Entering the Import Filename

5. Enter the Sequence program filename to be imported. If you do not know the filename to be imported, press [F1: Dir] to display a list of files available for import:

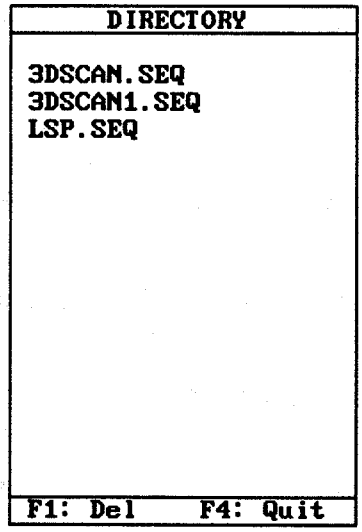


Figure 10-36 Directory of Files Available for Import

6. Use [↑] or [↓] to select the file to be imported and press ENTER. The following prompt is displayed:

   Save the Sequence program? [Y/N]

   - Press NO to open the Sequence Program screen without saving the sequence first. Note: You can save the Sequence program with a different name in the Sequence Program screen by pressing [F1: Save], or
   - Press YES to save the Sequence program under a different name. The Sequence Alphanumeric window (Fig. 10-3) is displayed. Enter the new Sequence ID and press ENTER.

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Note: The ID can be a combination of up to a maximum of 11 characters and numbers (*no spaces allowed*). When exporting a Sequence program, the ID gets automatically truncated to the first eight-characters. You can rename the Sequence program before exporting it with an eight-character name if desired.

To display the Sequence Program screen with the imported Sequence program, press MENU, then choose View/Modify from the Sequence menu and press ENTER.

10.9.4 BACKING UP SEQUENCE PROGRAMS

You have the choice of backing up Sequence programs only or you can back up the Sequence programs and their associated recipes.

> **NOTE:** **It is very important to back up Sequence programs regularly to guard against database corruption. If your database does get corrupted, see Section 18.2.6, "Database Recovery," for procedures on recovering a corrupted database.**

To back up Sequence programs:

You will need 3.5-in. formatted diskettes for the backup. To format diskettes, see Section 18.3.1, "Formatting Diskettes," for more information.

1. Change the disk path to the drive to which the data is to be backed up. See Section 7.9, "Saving Data and Recipes," for more information.
2. From any screen, press MENU one or more times until the menu bar is displayed and active.
3. Choose Maintain from the Sequence menu and press ENTER to display the Sequence Maintenance window (Fig. 10-34).
4. Choose Backup and press ENTER. The following prompt is displayed:

   Backup All Recipes Also? [Y/N]:

5. Press YES to back up the recipes with the Sequence programs or press NO to back up the Sequence programs only. The following prompt is displayed:

   Please insert backup volume 1
   Press any key to continue

6. When the backup diskette is full, the system displays the prompt:

   No More Usable Space on Backup Volume.
   Try Another [Y] or Suspend the Session [N]?

7. Press YES to insert another backup diskette or press NO to suspend the backup session if you do not have a backup diskette ready.

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Note: If you select Backup again after it was suspended, the system displays a prompt asking you if you want to resume the backup function.

8. When all the specified data is backed up, the system will display a message that the backup is complete.

10.9.5 RESTORING SEQUENCE PROGRAMS

> **CAUTION:** **Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."**

To restore Sequence programs:

1. Change the disk path to the drive from which you will restore the Sequence programs. See Section 7.9, "Saving Data and Recipes," for more information.
2. From any screen, press MENU one or more times until the menu bar is displayed and active.
3. Choose Maintain from the Sequence menu and press ENTER to display the Sequence Maintenance window (Fig. 10-34).
4. Choose Restore and press ENTER. The following prompt is displayed:

   Approximate restoration capacity is 5.0
   high-density diskettes. OK to Restore? [Y/N]

5. Press YES to continue restoring. The following prompt is displayed:

   Restore all Recipes found also? [Y/N]:

6. Press YES to restore recipes with the Sequence programs or press NO to restore the Sequence programs only.
7. The following prompt is displayed:

   Please insert backup volume 1
   Press any key to continue

> **NOTE:** **You must insert the backup diskettes in the same order that you used when backing up the Sequence programs. To display the order of the diskettes, see Section 18.2.6, "Database Recovery," for more information.**

8. The system will prompt for each succeeding backup diskette. When the restoration is complete, the following prompt is displayed:

   Restoration is Complete
   Press any key to continue

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9. Press any key to return to the Sequence Maintenance window.

10.10 MAINTAINING SEQUENCE DATA

For details on purging, importing, backing up, and restoring sequence data, see Section 12.4, "Maintaining the Database."

10.10.1 DELETING SEQUENCE DATA

See Section 12.3.5, "Deleting Data," for details on deleting sequence data.

10.10.2 EXPORTING SEQUENCE DATA

You can export sequence data only in the Automatic mode. The Export option must be set to export data before a Sequence program is run. Data is automatically exported each time a scan is completed. See Section 10.3.2, "Sequence Fields," earlier in this chapter for details on setting the Export option.

10.11 USING THE SECS INTERFACE OPTION WITH SEQUENCES

You can use the SECS option to upload and download Sequence programs to and from the host. Procedures for enabling and configuring the SECS Option and uploading and downloading Sequence programs are described in the following sections. For more information on the SECS option, refer to the *Tencor Profiler SECS Interface Manual.*

You also can upload sequence data to the host computer if you enable and configure the SECS Option before running a Sequence program. See Section 6.14, "Setting the SECS Interface Option to Upload Data," for details.

10.11.1 ENABLING AND CONFIGURING THE SECS OPTION

The SECS Option must be enabled and configured before you can upload or download Sequence programs. You do not need to configure the SECS interface each time you use the option.

To enable and configure SECS:

1. Choose SECS from the Config menu and press ENTER to display the SECS Communication window:



Figure 10-37 Enabling SECS

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2. Use [←] or [→] to select Enabled for Current Communication State. Press [F4: Quit] to exit the window or go to step 3 to configure the SECS Option.
3. Press [F1: Configure] to display the SECS Configuration window:

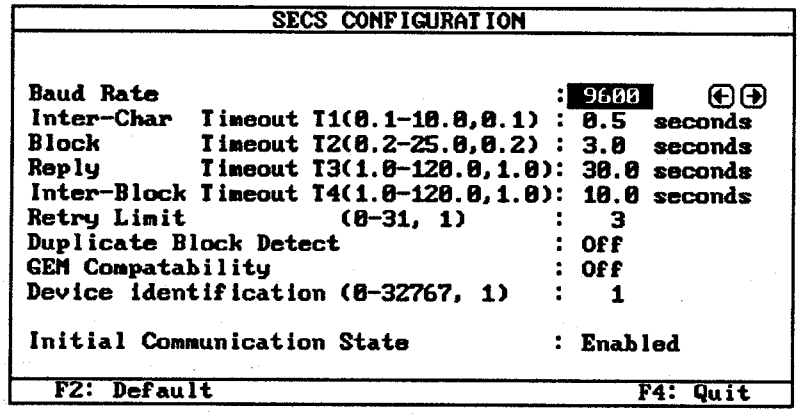


Figure 10-38 SECS Configuration Window

4. Press [F2: Default] to set the configuration to default values or set the values using the following list:

Option	Description
Baud Rate	Available speeds are 300, 600, 1200, 2400, 4800, and 9600. The default speed is 9600.
Inter-Char Timeout	The range allowed is 0.1 to 10 s at increments of 0.1s. The default value is 0.5 s.
Block Timeout	Also referred to as the Protocol Timeout. The range allowed is 0.2 to 25 s at increments of 0.2 s. The default value is 3 s.
Reply Timeout	Also referred to as the Transaction Timeout. The range allowed is 1 to 120 s at increments of 1 s. The default value is 30 s.
Inter-Block Timeout	The range allowed is 0 to 120 s at increments of 1s. The default value is 10 s.
Retry Limit	Also referred to as the Transmit Failure Retry Limit. The range allowed is 0 to 31 at increments of 1. The default value is 3.
Duplicate Block Detect	Can be enabled (On) or disabled (Off). The default value is Off.

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Option	Description
GEM Compatibility	Uses S1F65 (GEM) or S1F1 to establish connection. Can be On or Off. The default value is On.
Device Identification	Specified as a value from 0 to 32,767 (15 bits). The default value is 0.
Initial Communication State	Can be Enabled or Disabled. The default value is Enabled.

5. Press [F4: Quit] to save the values and exit the window. The SECS Communication window is displayed. Press [F4: Quit] to exit the Communication window.
6. If your instrument has the wafer handler installed, you must reset the instrument to activate the new settings. From the main menu bar, choose To DOS from the Exit menu and press ENTER. Type *y* when asked to confirm that you wish to return to DOS. The DOS prompt is displayed. Press RESET.

10.11.2 UPLOADING A SEQUENCE PROGRAM TO THE HOST

You must enable and configure the SECS Option before uploading Sequence programs to the host.

To upload a Sequence program from the host:

1. If necessary, enable and configure the SECS Option. See Section 10.11.1, "Enabling and Configuring the SECS Option," for details. You do not need to enable or configure SECS each time a Sequence program is uploaded or downloaded.
2. Choose To Host from the Sequence menu and press ENTER to display the Upload Sequence to Host catalog (Fig. 10-39):

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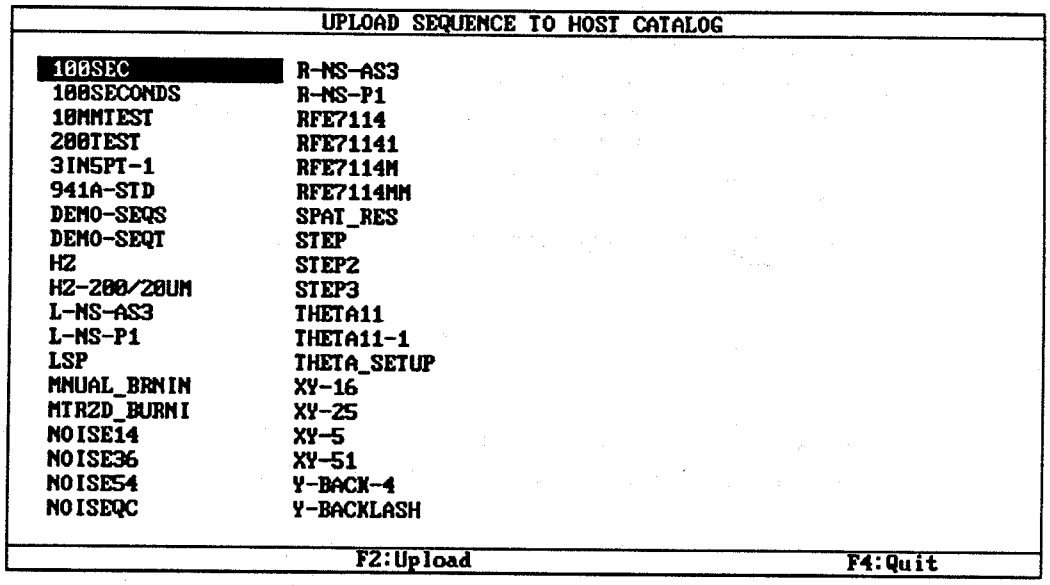


Figure 10-39 Uploading a Sequence Program to Host

3. Use [↑] or [↓] to select the Sequence program to be uploaded.
4. Press [F2: Upload].

10.11.3 DOWNLOADING A SEQUENCE PROGRAM FROM THE HOST

The SECS Option must be enabled and configured before you can download Sequence programs from the host.

To download a Sequence program from the host:

1. If necessary, enable and configure the SECS Option. See Section 10.11.1, "Enabling and Configuring the SECS Option," for details. You do not have to enable or configure the SECS Option each time that you upload or download a Sequence program.
2. Choose From Host from the Sequence menu and press ENTER. The Alphanumeric ID window is displayed:

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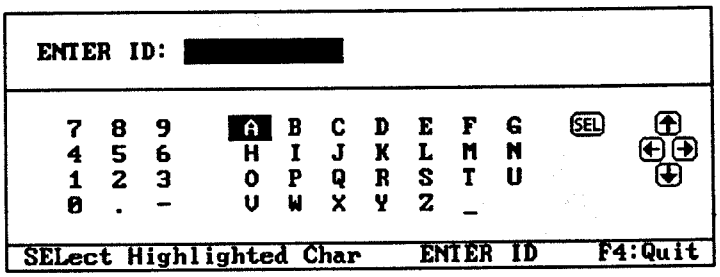


Figure 10-40 Alphanumeric Window

3. Enter the name of the Sequence program to be downloaded from the host and press ENTER. The following window is displayed:

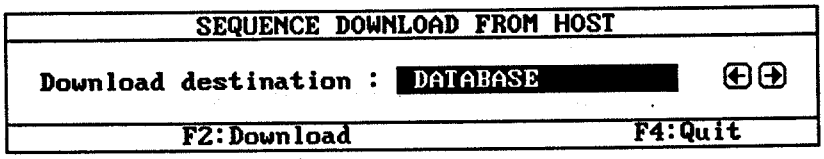


Figure 10-41 Downloading a Sequence Program

4. Use [←] or [→] to select a destination. Available destinations are Database, Current Sequence, and DB + Current Sequence.
5. Press [F2: Download] to download the sequence.

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11 SORT/COMBINED STATISTICS OPTION

The Sort/Combined Statistics Option offers increased data analysis capability by providing additional statistical analysis for process control. This option is available with the Sequence Option only.

You can combine sequence results of up to 25 samples run with the same sequence program. This option enables you to

- Compute and store statistical information for specific production lots
- Combine and analyze data from up to 25 sequence results (with the same Sequence ID)
- Recall and combine the analyzed data, if saved, with data from other production lots for further analyses
- Combine sequence results for both sides of samples and average out the data for all the locations

Keep the following in mind when selecting the sequence results for the Combined Statistics Option:

- Each sequence result that you combine should have statistics data.
- You can only combine sequence results with the same Sequence ID. If you attempt to combine sequence results with different Sequence IDs, an error message is displayed.
- You can combine only 25 sequence results at one time. To combine more than 25, first combine 25 sequence results. Then combine the results of the first 25 with the next 25 results, and so on.
- You cannot upload or download combined sequence results to and from the host using the SECS Option; you can only upload sequence data during or after a sequence run.

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11.1 COMBINING STATISTICS

To combine the statistics:

1. Select Comb Stat from the Data menu and press ENTER. The Database Recall IDs window is displayed:

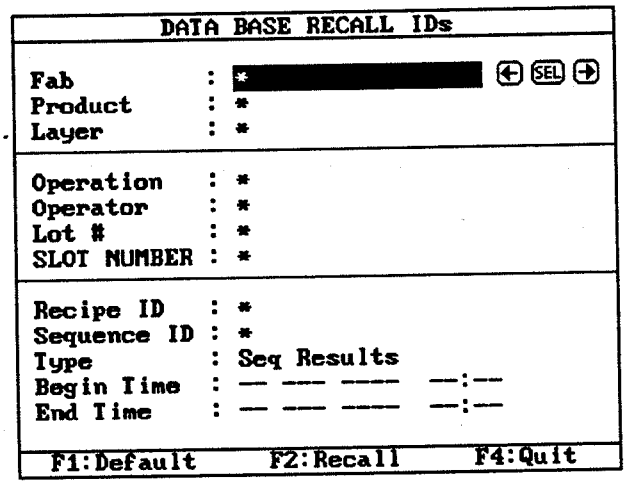


Figure 11-1 Database Recall IDs

Data is saved using seven user-configurable IDs (the first 7 IDs in Fig. 11-1) and five data-dependent IDs (the last five IDs in the above figure). See Section 12.3.2, "Saving Data with Assigned Values," for more information on saving data.

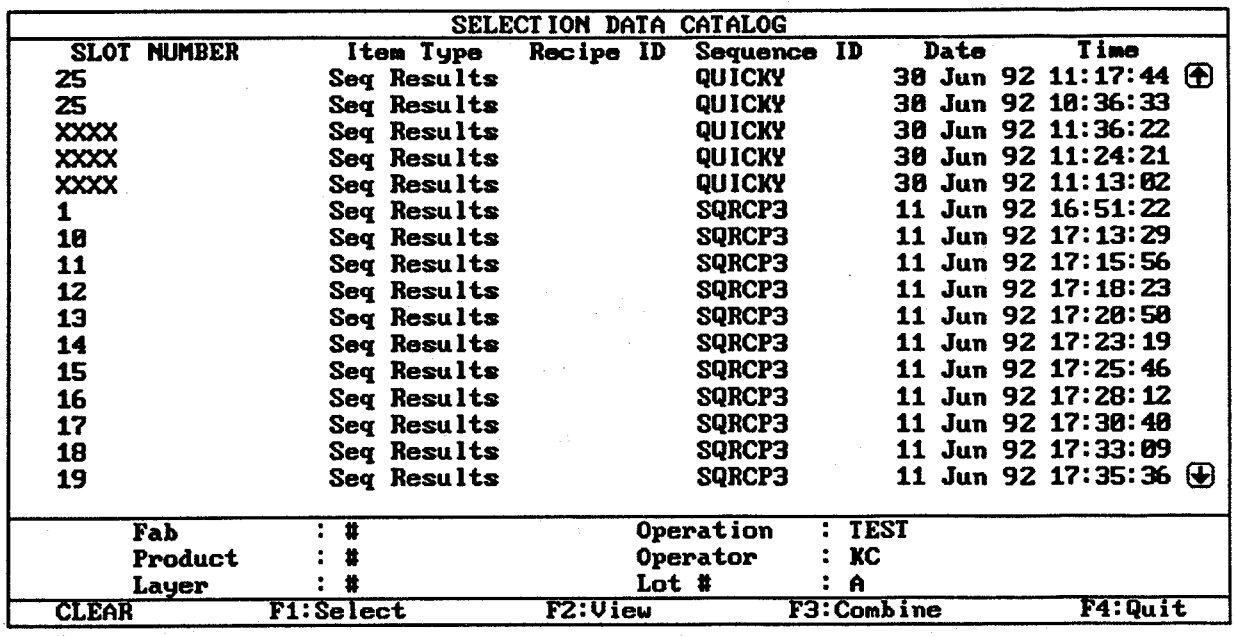
2. To recall sequence results:

   - Use [↑] or [↓] to move between the IDs.
   - Use [←] or [→] to select available values for the IDs.
   - If sequence data was saved using the default value (#), press [F1: Default] to enter # as an identifier in the first seven IDs (Fab, Product, Layer, Operation, Operator, Lot #, and Slot Number in Fig. 11-1). Section 12.3, "Operating the Database," provides more information on default values.
   - Entering values for Type, Begin Time, and End Time is optional. These three categories are useful if you have a very large amount of sequence data in the database or if you know the time frame during which the sequence data was saved.
   - To display the entire database, enter * in all the IDs, except Type, Begin Time, and End Time.

   See Section 12.3.3, "Recalling Data," for more information on recalling data using assigned values and default values.

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3. Press [F2: Recall] to display the Selection Data catalog:



SELECTION DATA CATALOG

SLOT NUMBER	Item Type	Recipe ID	Sequence ID	Date	Time
25	Seq Results		QUICKY	30 Jun 92	11:17:44
25	Seq Results		QUICKY	30 Jun 92	10:36:33
XXXX	Seq Results		QUICKY	30 Jun 92	11:36:22
XXXX	Seq Results		QUICKY	30 Jun 92	11:24:21
XXXX	Seq Results		QUICKY	30 Jun 92	11:13:02
1	Seq Results		SQRCP3	11 Jun 92	16:51:22
10	Seq Results		SQRCP3	11 Jun 92	17:13:29
11	Seq Results		SQRCP3	11 Jun 92	17:15:56
12	Seq Results		SQRCP3	11 Jun 92	17:18:23
13	Seq Results		SQRCP3	11 Jun 92	17:20:50
14	Seq Results		SQRCP3	11 Jun 92	17:23:19
15	Seq Results		SQRCP3	11 Jun 92	17:25:46
16	Seq Results		SQRCP3	11 Jun 92	17:28:12
17	Seq Results		SQRCP3	11 Jun 92	17:30:40
18	Seq Results		SQRCP3	11 Jun 92	17:33:09
19	Seq Results		SQRCP3	11 Jun 92	17:35:36

Fab : # Operation : TEST
Product : # Operator : KC
Layer : # Lot # : A

CLEAR F1:Select F2:View F3:Combine F4:Quit

Figure 11-2 Selection Data Catalog with Selected Sequence Results

4. To select sequence results:

   - Use [↑] or [↓] to highlight the sequence result and press [F1: Select]. An ampersand (&) is placed before each selected sequence result. Highlight the next sequence result and press [F1: Select]. Note: [F1: Select] is a toggle. You can select and deselect sequence results by pressing [F1: Select].
   - To clear all selections, press CLEAR/NO.
   - To view any sequence result, highlight the sequence result and press [F2: View].
   - You can combine up to a maximum of 25 sequence results. To combine more than 25, first combine 25 sequence results. Then combine the results of the first 25 with the next 25 remaining sequence results and so on.

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5. After selecting all the desired sequence results, press [F3: Combine]. The following window is displayed:

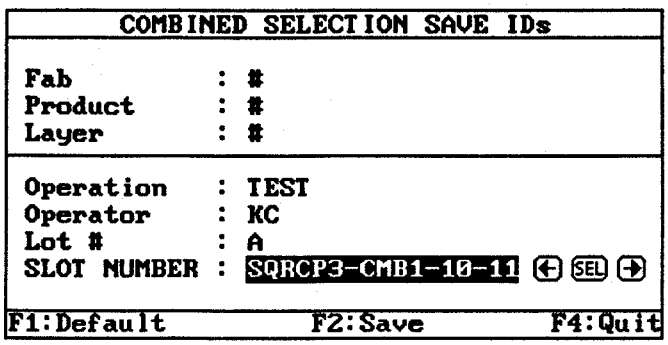


Figure 11-3 Combined Selection Save IDs Window

6. Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs.

   - The first six IDs will have the common ID values of the sequence results being combined. The default value # will be entered for those IDs that do not have the same value in all the sequence results being combined.
   - You also can enter new values for the IDs. Each ID value can be a combination of up to a maximum of 17 characters and numbers (*no spaces allowed*). Note: When exporting data, the ID will automatically get truncated to the first eight characters.
   - Enter a unique ID for the last label. For example, you can save all combined statistics data with "CMB" as the prefix or the suffix to distinguish it from regular sequence results.

7. When you finish entering values for the IDs, press [F2: Save] to combine the data. The message, "Combining the Statistics, please wait," is displayed while the statistics are being combined. After the results have been combined, the Sequence Data window (Fig. 11-4) is displayed:

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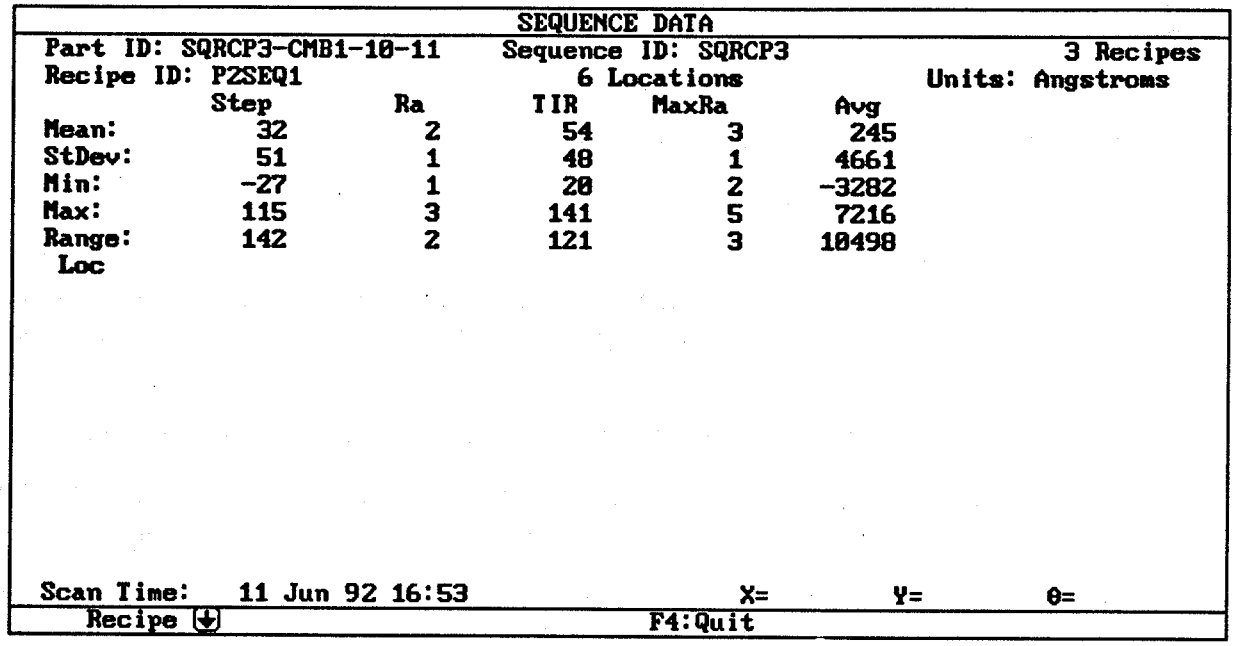


Figure 11-4 Combined Sequence Data Screen

All parameter units are in Angstroms or microinches, depending on the units selected in the Scan recipe. The Sequence Data screen for the Combined Statistics Option displays the following information grouped by Scan recipes:

- Statistics for each parameter selected in the recipes. Statistics displayed are the mean, standard deviation, minimum, maximum, and range for each parameter selected. Statistics are calculated for scans taken using the same Scan recipe.
- Sequence and Recipe IDs.
- The total number of Scan recipes used in the sequence.
- Number of locations.
- Scan Time is the date and time that the statistics were combined.
- X, Y, and theta coordinates will not be displayed and these fields will always be blank.

Press [↑] or [↓] to display data collected with a different Scan recipe. Note the arrow prompt in the lower left corner of the screen. The number of data windows that can be displayed from each Combined Data screen depends on the number of recipes.

8. When you are done, press [F4: Quit] to exit the window. The Sequence catalog is displayed.
9. Press CLEAR to deselect the selected sequence results. Note: The sequence results will remain selected until you deselect them.

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11.2 PRINTING COMBINED SEQUENCE RESULTS

To print the Combined Sequence results:

1. Display the Combined Sequence Data screen (Fig. 11-4):
   - Press MENU (several times if necessary) to display the menu bar.
   - Select Comb Stat from the Data menu and press ENTER. The Database Recall IDs window is displayed. See Fig. 11-1. See step 2 in Section 11.1, "Combining Statistics," for details on entering values in the Database Recall IDs window.
   - Press [F2: Recall] to display the Selection Data catalog. See Fig. 11-2.
   - Use [↑] or [↓] to highlight the desired combined sequence result and press ENTER to display the Combined Sequence Data screen (Fig. 11-4).
2. Press PRINT on the built-in keyboard or PRINT SCREEN (*not* SHIFT + PRINT SCREEN) on the remote keyboard to print the combined sequence data on a compatible black and white or color printer. The Sequence Print Choice window is displayed:

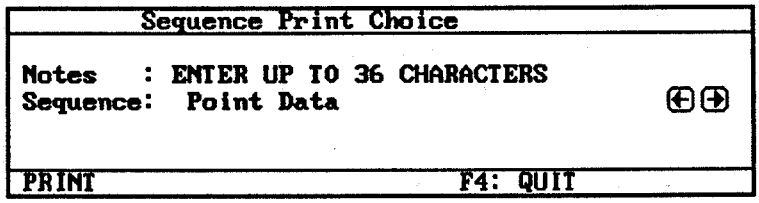


Figure 11-5 Printing Sequence Data

3. If desired, enter a comment such as a description or an explanation of the data. The note can be a maximum of 36 characters.
4. In the Sequence field, press [←] or [→] to select Statistics.
5. Press PRINT or PRINT SCREEN to initiate printing or [F4: Quit] to abort the operation.

11.3 MAINTAINING COMBINED SEQUENCE RESULTS

For details on purging (deleting), importing, backing up, and restoring combined sequence results, see Section 12.4, "Maintaining the Database."

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12 DATABASE MANAGER OPTION

12.1 INTRODUCTION

The Database Manager Option enables you to organize the data collected for easy manipulation and analysis. A *configuration section* is provided for the supervisor to set up and configure the database. A *tutorial* is also included at the end of this chapter to help you become familiar with the different aspects of the Database Manager.

The Database Manager Option is available for the Automatic Long Scan Profiler only. It allows you to

- Save and retrieve data using up to seven categories of user-definable identifiers. Keylocked operations can be restricted to save data to preset values.
- Recall summaries, 2-D data, 3-D data, sequence results, and point data.
- Delete, back up, and restore data in the database.
- Export data in ASCII format so that it can be read by other software programs.
- Import data in binary format that was previously exported in the same format.
- Set and change the database password.

12.1.1 HOW THE DATABASE WORKS

Each item of data is saved using seven categories of user-configurable IDs (the first seven IDs in the figure below) and five IDs assigned by the system.

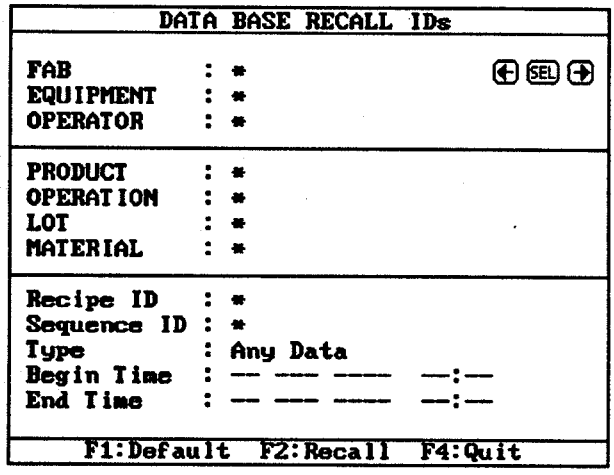


Figure 12-1 Database Recall IDs Window

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The first three IDs (Fab, Equipment, and Operator in Fig. 12-1) are the *major Data IDs*. The major IDs must have values attached to them before you can save single scan data in the database. Since these are essential criteria, it is advisable to set up labels and values for these criteria before saving single scan data. Note: Sequence or recipe data provide the three major Data ID values from the sequence or recipe settings.

The next four IDs (Product, Operation, Lot, and Material in Fig. 12-1) are the *minor Data IDs*. These IDs also must have values attached to them before you can enter single scan data into the database.

The last five IDs (Recipe ID, Sequence ID, Type, Begin Time, and End Time in Fig. 12-1) are the *data-dependent IDs*. These are assigned by the system and are used to identify segments of data saved during a particular time frame, the same type of data, etc. You can select pre-existing values for these IDs for the recall function only.

- *Recipe ID* is the name of the recipe.
- *Sequence ID* is the name of the sequence (if any).
- *Type* has six preset values: raw trace, point data, sequence results, 3-D data, and any data. Statistics data is supplied within sequence results.
- *Begin Time* selects items after this time only.
- *End Time* selects items until this time only.

The labels identifying the Data ID categories should be set up prior to data collection. Labeling ID categories is an administrative function and is protected by a password.

Data is saved, recalled, or exported using assigned values, wild cards, or default values.

Assigned Values: Data is saved using these values and you can save, recall, or export specific items of data using assigned values. We recommend that the supervisor or a keylock level 3 operator set up values.

Default Values: The pound (#) symbol is used as the default value in the database. When saving data, use the default value for any of the Data IDs when you do not want to use any particular value. You can enter the default value for all or some of the major and minor Data IDs to save, recall, or delete data. Note: Even though you have the option of entering default values for all IDs, enter a value for the last ID so that data can be easily identified.

Wildcards: The star (*) symbol is used as a wildcard. Use this symbol when recalling data to list all the data in the Database catalog. You cannot save data using wildcards.

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12.1.2 DATABASE STRUCTURE

Figure 12-2 illustrates a data branch in a sample database. As you can see in the figure, data is saved using three layers (levels) of IDs: Layer 1 identifiers are the major Data IDs, Layer 2 identifiers are minor Data IDs, and Layer 3 identifiers are data-dependent IDs. In the example given in the figure, the first major Data ID, Fab, has three values — Fab 1, Fab 2, and Fab 3.

Fab 1 has two Product (second major Data ID) values. Each second major Data ID, Product, has three values for the third major Data ID Layer. Then for each combination of the major IDs, each Layer 2 and Layer 3 ID has two values.

NOTE: **The database configuration should be kept as narrow as possible at the top. An unlimited expansion of values at the major Data ID level will result in the database operations slowing down, and you will find it difficult to keep track of all the data branches.**

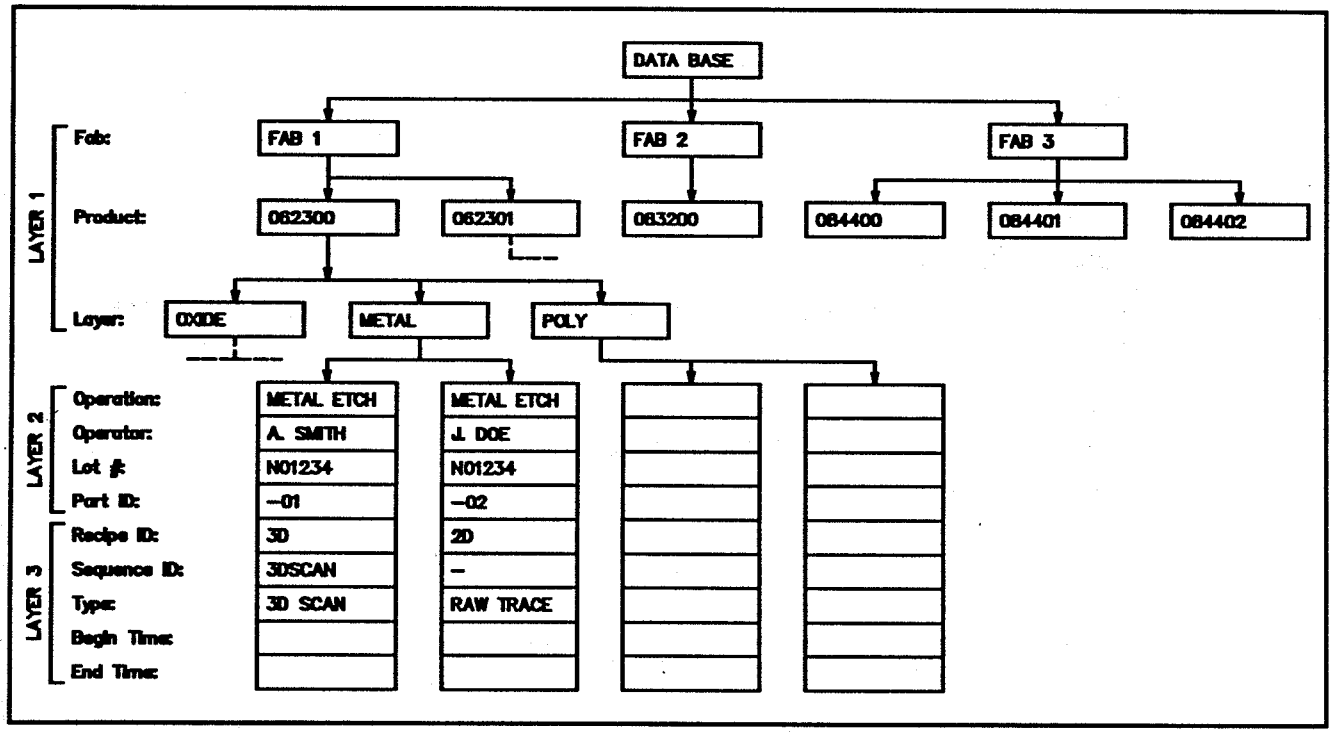


Figure 12-2 Data Branch in Sample Database

Only the first layer (major IDs) is hierarchical. If you enter a value for the first major Data ID and then go to the second Data ID and press SEL, only those values that are related to the first major Data ID will be displayed. Similarly, if values have been selected for the first and second major Data IDs, only those values that are related to the first major Data ID will be displayed. The minor data ID list windows display all available values independent of the values selected for any of the major Data IDs.

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12.2 CONFIGURING THE DATABASE

This section applies to the supervisor only. The supervisor should configure the database before operators, especially keylock 1 and keylock 2 level operators, begin taking new scans. See Section 3.8, "Setting the Keylock Position," for more information on keylock positions. Database configuration involves two steps:

1. Setting major and minor Data ID labels
2. Adding, deleting, and renaming major Data ID values

Each step is explained in the following sections.

12.2.1 SETTING MAJOR AND MINOR DATA ID LABELS

You can set or change the labels, according to your needs, for the major and minor Data IDs. See Section 12.1.1, "How the Database Works," earlier in this chapter for a description of the major and minor Data IDs. We recommend that you set or change labels only after careful planning.

> **CAUTION:** **Do not switch or change the meaning of Data ID labels once the database has been initially configured and data has been entered. Switching the labels will not move the data to the new labels.**

To set or change ID labels:

1. Choose Database from the Config menu and press ENTER to display the Database Password window:

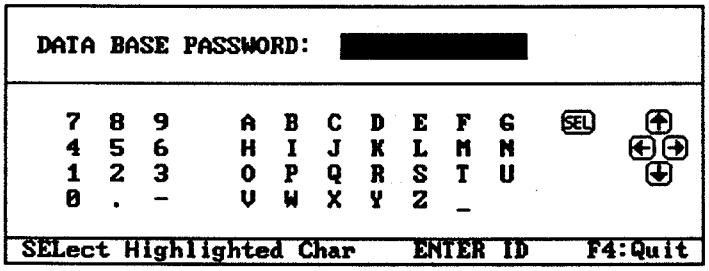


Figure 12-3 Database Password Window

- If this is the first time you have opened the Database Password window, see Section 12.2.4, "Setting or Changing the Password," for more information on the database password.
- If you have forgotten the password, refer to Section 12.2.4, "Setting or Changing the Password," for instructions on displaying the password in DOS.

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2. Type the password (initially set by Tencor Instruments to P2) and press ENTER to open the Database Configuration window. (Note: For security reasons the password will not appear in the Database Password window.)

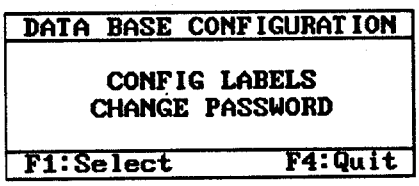


Figure 12-4 Database Configuration Window

3. Choose Config Labels and press [F1: Select] to display the Data ID Labels window, similar to the one displayed below.

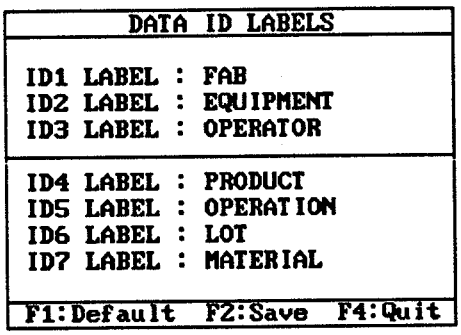


Figure 12-5 Configuring Database ID Labels

Note: When you open the window the first time, it will display labels preset by Tencor Instruments at the factory. Any or all of the labels can be changed.

4. To enter new values, use [↑] or [↓] to move up or down from each value. Type new values as desired and press [F2: Save] to save your edits.

5. The system displays the message

   Saving System Configuration, Please Wait

   and returns you to the Database Configuration window.

6. Press [F4: Quit] to return to the main menu bar.

To set default ID labels:

1. Repeat Steps 1, 2, and 3 in "To set or change ID labels" above.
2. To set the ID labels to default values, press [F1: Default]. (Note: These default values have been preset by Tencor Instruments and cannot be changed.)
3. Press [F4: Quit] to exit.

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12.2.2 ADDING/DELETING/RENAMING MAJOR ID VALUES

Each major and minor ID can be assigned any number of values. We recommend that the database configuration be kept as narrow as possible at the top.

> **NOTE:** An unlimited expansion of values at the Major ID level will result in the database operations slowing down, and you will find it difficult to keep track of all the data branches.

The supervisor should add, delete, and rename major ID values.

To add Major ID values:

1. Choose Catalog from the Data menu and press ENTER to display the following window:

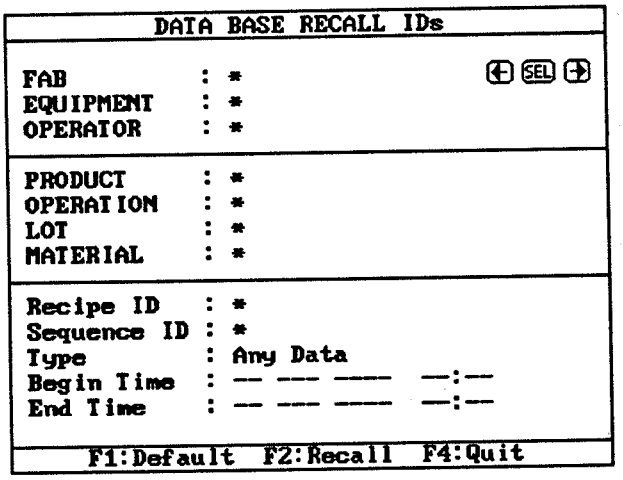


Figure 12-6 Database Recall IDs Window

2. Use [↑] or [↓] to choose a Data ID for which you want to add values, and press SEL on the built-in keyboard or SPACEBAR on the remote keyboard. A window listing all available values for that particular Data ID is displayed (Fig. 12-7).

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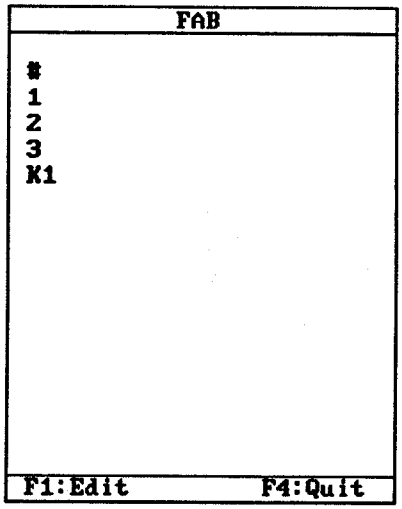


Figure 12-7 ID Value List

NOTE:	You can add, delete, or change ID values in all ID Value List windows that have [F1: Edit] displayed at the bottom of the ID Value List window (see Fig. 12-7).

3. Press [F1: Edit] to open the Editing window similar to the one displayed below:

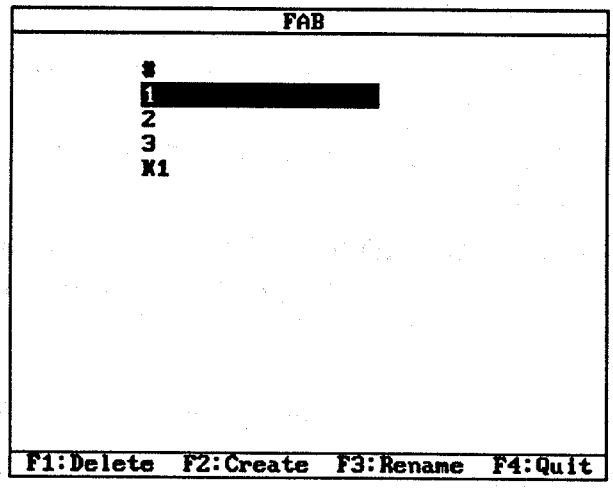


Figure 12-8 Editing ID Values

The values will be listed alphabetically with the first value highlighted.

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4. Press [F2: Create] to open the Create ID Value window similar to the one displayed below:

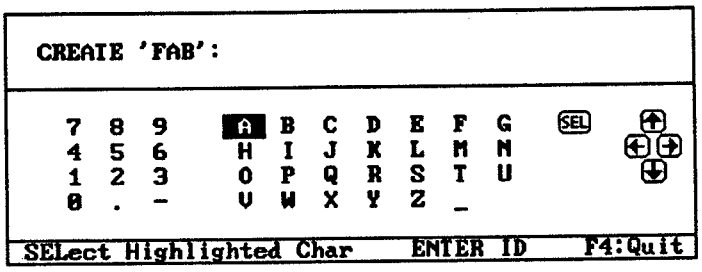


Figure 12-9 Create ID Value Window

5. Type in a new value (no spaces between the characters) and press ENTER. Note: Each ID value can be a combination of up to a maximum of 17 characters and numbers (no spaces allowed). When exporting an item of data, the ID value gets automatically truncated to the first eight characters. To export an item with an eight-character name, rename the item before exporting it.

To delete Major ID values:

> **NOTE:** **You cannot delete values that have data or lower ID values attached to them. To delete values that have data attached to them, first delete the data by using the Purge function of the Data Maintenance menu (see Section 12.4.2, "Purging Data"). Then delete the values, deleting the lower values first, using the procedure given below.**

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-6).
2. Use [↑] or [↓] to choose the Data ID for which you want to delete values and press SEL on the built-in keyboard or the spacebar on the remote keyboard. A window listing all available values for that particular Data ID is displayed (Fig. 12-7).
3. Press [F1: Edit] to display the ID Value Editing window (Fig. 12-8).
4. Use [↑] or [↓] to choose the value to be deleted and press [F1: Delete] to delete the value. The following prompt is displayed:

   Do You Really Want to Delete This ID? [Y/N]

5. Press YES to delete the value or press NO to return to the Database Recall IDs window (Fig. 12-6) without deleting the value.

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To rename Major ID values:

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-6).
2. Use [↑] or [↓] to choose any major Data ID and press SEL on the built-in keyboard or the spacebar on the remote keyboard. A window listing all available values for that particular Data ID is displayed (Fig. 12-7).
3. Press [F1: Edit] to display the Editing window (Fig. 12-8).
4. Use [↑] or [↓] to choose the value to be renamed and press [F3: Rename] to display the following window:

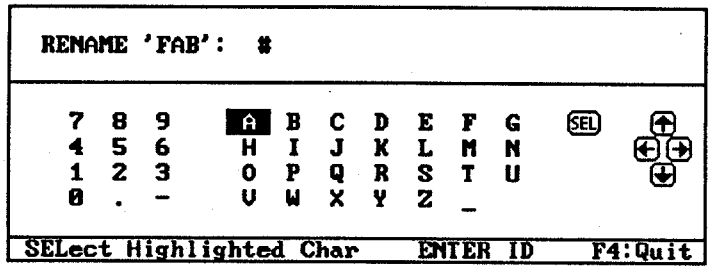


Figure 12-10 Renaming a Data ID

5. Type a new name and press ENTER.

12.2.3 RESTRICTING ACCESS TO DATA ID VALUES

The supervisor can preset Data ID values to be used for saving data by keylock 1 and keylock 2 operators.

> **NOTE:** **All but one of the seven major and minor Data ID values can be preset.**

One ID must be left blank to be entered by the operator. Enter the wildcard (*) for the ID left unrestricted. See Section 12.1.1, "How the Database Works," earlier in this chapter for more information on wildcards. Though there is no restriction on which Data ID should be left unrestricted, we recommend that the last minor ID (Material in Fig. 12-6) be left unrestricted.

When a keylock 1 or 2 level operator saves data, the Database Recall IDs window is displayed with preset values for the restricted major and minor Data IDs. The window displays wildcards for the unrestricted IDs. The operator can enter values for the unrestricted Data IDs only.

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To restrict access to Data ID values:

1. Choose Setup from the Data menu and press ENTER to display the Restricted Save IDs window similar to Fig. 12-11:

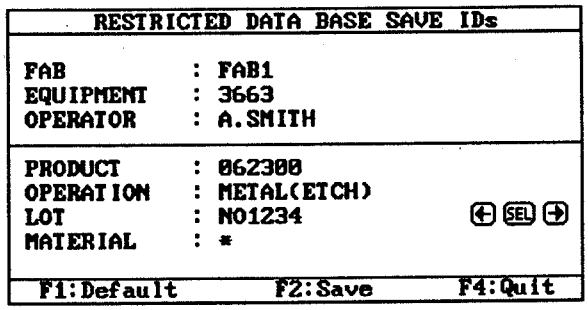


Figure 12-11 Restricting Access to Save ID Values

2. Use [↑] or [↓] to select IDs and use [←] or [→] to select available values.
3. Type * for the unrestricted ID or IDs and press [F2: Save] to save the Restricted Save IDs window. See Section 12.1.1, "How the Database Works," for more information on wildcards.

12.2.4 SETTING OR CHANGING THE PASSWORD

The password will be set to the value P2 when the Tencor P-2 is initialized. Change the password to a desired value when you configure the database. This password is not a keyboard lock but restricts access to changing the Data ID labels.

> **NOTE:** **Password access should be restricted in order to prevent indiscriminate changing of Data ID labels.**

Setting or changing the password:

1. Choose Database from the Config menu and press ENTER to display the Database Password window (Fig. 12-3).
2. Type *p2* (or whatever value has been set for the password) and press ENTER to display the Database Configuration window (Fig. 12-4).

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3. Use [↑] or [↓] to choose Change Password and press [F1: Select] or ENTER to display the following window:

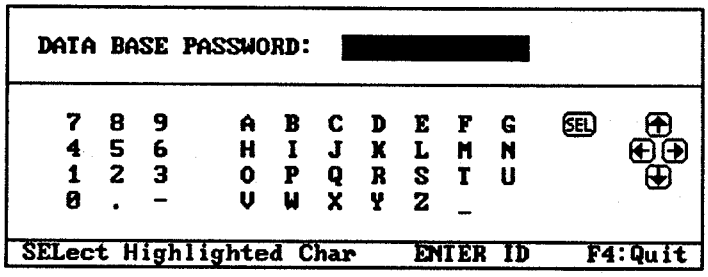


Figure 12-12 Entering a New Password

4. Type the new password and press ENTER to save the password. The system displays the following message:

   Saving System Configuration, Please Wait

5. Press [F4: Quit] to exit the Password window without changing the password.

To recall the password using DOS:

If you wish to configure the database or change and set Data ID labels and cannot recall the password, use the following instructions.

> **NOTE:** **The following program is stored in the UTILITIES directory on drive C, but you should run the program in the C:\TENCOR directory, which stores the Tencor P-2 software on your machine. To change directories see below.**

1. Choose To DOS from the Exit menu and press ENTER to exit the Tencor P-2 program.
2. At the DOS prompt, type *cd c:\tencor* and press ENTER. The prompt will read C:\TENCOR.
3. At the C:\TENCOR prompt, type *db_pwd* and press ENTER to display the password.

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12.3 OPERATING THE DATABASE

This section provides information on recalling, saving, and exporting data using the Database catalog, the Database Save IDs, and the Database Recall IDs windows.

> **NOTE:** **If this is the first time you are using the Tencor P-2 database and if you are a supervisor, configure the database before taking new scans. Refer to Section 12.2, "Configuring the Database," for information on configuring the database.**
> **If you are not the supervisor and are using the database for the first time, make sure the database is configured before you begin taking new scans.**

Data is saved, recalled, or exported using assigned values, wild cards, or default values. See Section 12.1.1, "How the Database Works," for more information.

The Database Recall IDs window displayed below is a sample database window. Other database windows in the Restore, Backup, Purge, and Save functions are also similar to the Database Recall IDs window.

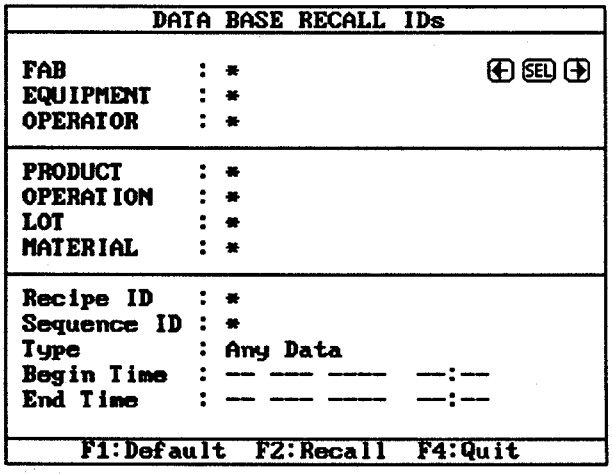


Figure 12-13 Database Recall IDs Window

In all windows, Data ID labels are listed on the left side and values are entered opposite to labels. As you can see in the above figure, the Database Recall IDs window is divided into three parts:

Major Data IDs: The first three IDs are the major Data IDs and must have values attached to them before you can enter single scan data into the database.

Minor Data IDs: The middle four IDs are minor Data IDs and also must have values attached to them before you can enter single scan data into the database.

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Data-Dependent IDs: The last five Data IDs—Recipe ID, Sequence ID, Type, Begin Time, and End Time—are not set by the user. You can select preexisting values for these IDs for the recall function only.

See Section 12.1.1, "How the Database Works," for more information on major, minor, and data-dependent IDs.

12.3.1 SAVING DATA WITHOUT ASSIGNED VALUES

> **CAUTION:** **Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."**

To save data using default values:

The pound (#) symbol is used as the default value in the database feature. Use # to save your data if you do not care to save data according to a hierarchy.

1. After taking a scan (see Chapter 6, "Profiling a Sample," for information on taking a scan), press [F2: Save]. The Database IDs window is displayed:

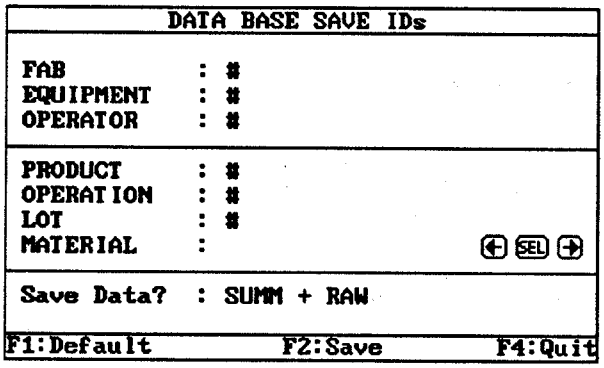


Figure 12-14 Database Save IDs

2. To enter default values for all the major and minor IDs (except the last minor ID), press [F1: Default]. Enter a value for the last minor ID so that the data can be easily identified.
3. When done entering values, press [F2: Save] or ENTER to save the data and the trace.

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12.3.2 SAVING DATA WITH ASSIGNED VALUES

This section describes saving data using assigned values, wildcards, or default values.

To save data using assigned or new values:

In the keylock 1 or 2 position, you can enter new values or change values for only those major or minor IDs that have the wildcard. There are no restrictions on entering new or using preexisting values in the keylock 3 position.

1. After taking a scan (see Chapter 6, "Profiling a Sample," for information on taking a scan), press [F2: Save]. A Database Recall IDs window similar to the one below is displayed.

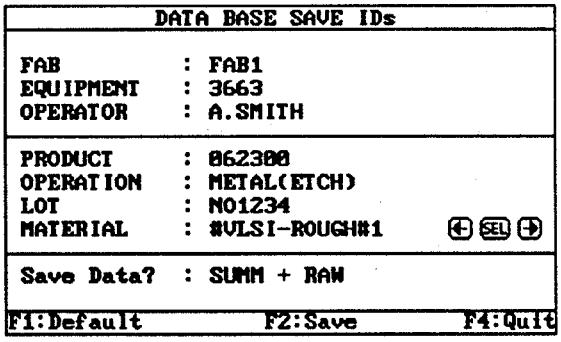


Figure 12-15 Database Save IDs Window

The Recipe ID, Sequence ID, type of data, and data that the data was saved is also automatically saved.

2. To enter new values, use [↑] or [↓] to select any category and type in the value. Note: Each ID value can be a combination of up to a maximum of 17 characters and numbers (no spaces allowed). When exporting an item of data, the ID value gets automatically truncated to the first eight characters. New values entered will be automatically added to the ID value list.

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3. Use [↑] or [↓] to select any of the IDs, and press SEL on the built-in keyboard or SPACEBAR on the remote keyboard. A window listing all available values for that particular Data ID is displayed (Fig. 12-16).

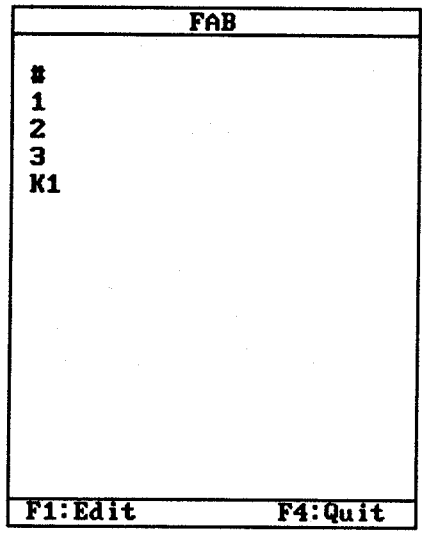


Figure 12-16 ID Value List

Use [↑] or [↓] to select any of the values and press ENTER to enter the value for that particular ID.

4. Press [F2: Save] to save the scan and data.

12.3.3 RECALLING DATA

You can recall data using any combination of assigned values, default values, or wildcards for the major, minor, and data-dependent IDs.

> **NOTE:** **The system will not allow you to use any ID value that does not exist.**

To recall data using assigned values:

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-13).
2. Enter values or use [←] or [→] to display the available values for each Data ID. You also can display the Data ID values list for each Data ID by pressing SEL on the built-in keyboard or the spacebar on the remote keyboard.

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> **NOTE:** If you try to enter a nonexistent major Data ID value, the system changes it to a wildcard and also gives you a warning that the ID value you are trying to enter does not exist.

3. Enter values for the data-dependent IDs—Recipe ID, Sequence ID, Type, Begin Time, and End Time—to narrow the search for data.

   If you specify Begin Time and End Time, the system will search for the data in the specified time block.

To specify Begin Time or End Time:

- To specify the time bracket for which the data will be deleted, use [←] or [→] to choose Begin Time or End Time. Press SEL on the built-in keyboard or SPACEBAR on the remote keyboard. The following window is displayed for the Beginning Time Limit:

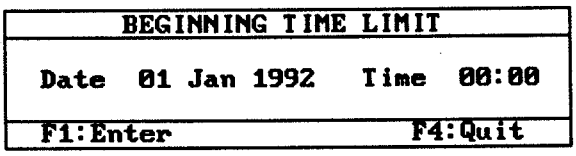


Figure 12-17 Specifying Beginning Time

The following window is displayed for the Ending Time Limit:

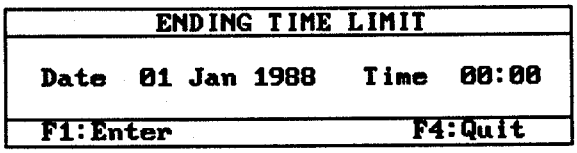


Figure 12-18 Specifying Ending Time

- Use [←] or [→] to move between month, year, and time. Use [↑] or [↓] to display the desired date, month, and time and press [F1: Enter] to enter the time bracket.

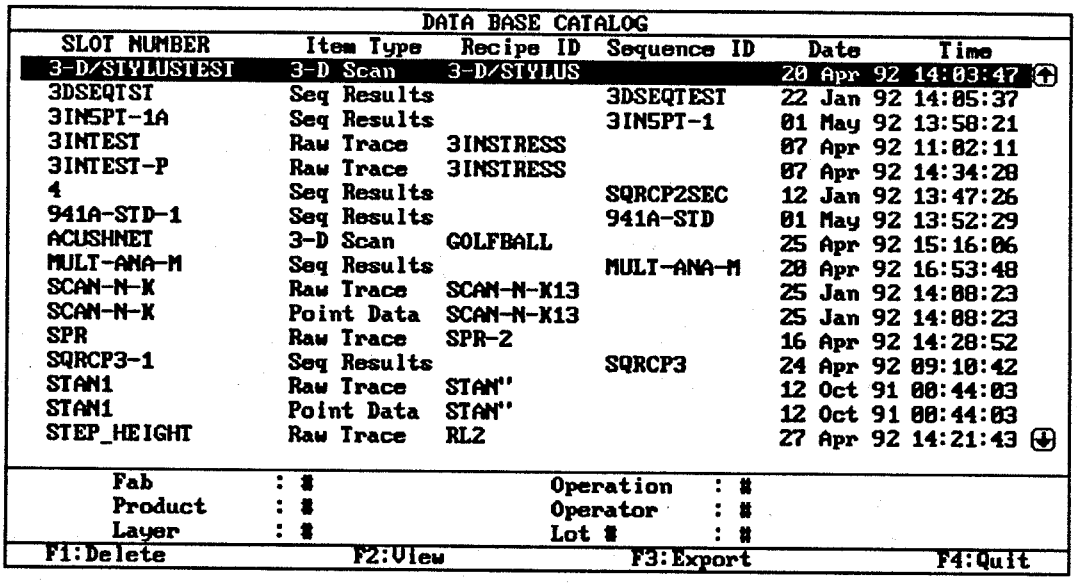
4. After you have entered values for each of the major, minor, and data-dependent IDs, press [F2: Recall] or ENTER to display the data and trace.

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To recall data using wildcards:

The star (*) symbol is used as a wildcard. Enter wildcards for all the major and minor Data IDs to list the entire database. Enter a combination of wildcards and known values to list sections of the database.

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-13).
2. To enter the wildcard, use [↑] or [↓] to select any Data ID and press CLEAR on the built-in keyboard or DELETE on the remote keyboard. You also can specify values for the data-dependent IDs.
3. When done entering wildcards (or values) for the rest of the major and minor Data IDs, press ENTER to display the Database catalog:



DATA BASE CATALOG

SLOT NUMBER	Item Type	Recipe ID	Sequence ID	Date	Time
3-D/STYLUSTEST	3-D Scan	3-D/STYLUS		20 Apr 92	14:03:47
3DSEQTST	Seq Results		3DSEQTEST	22 Jan 92	14:05:37
3IN5PI-1A	Seq Results		3IN5PT-1	01 May 92	13:58:21
3INTEST	Raw Trace	3INSTRESS		07 Apr 92	11:02:11
3INTEST-P	Raw Trace	3INSTRESS		07 Apr 92	14:34:28
4	Seq Results		SQRCP2SEC	12 Jan 92	13:47:26
941A-STD-1	Seq Results		941A-STD	01 May 92	13:52:29
ACUSHNET	3-D Scan	GOLFBALL		25 Apr 92	15:16:06
MULT-ANA-M	Seq Results		MULT-ANA-M	28 Apr 92	16:53:48
SCAN-N-K	Raw Trace	SCAN-N-K13		25 Jan 92	14:08:23
SCAN-N-K	Point Data	SCAN-N-K13		25 Jan 92	14:08:23
SPR	Raw Trace	SPR-2		16 Apr 92	14:28:52
SQRCP3-1	Seq Results		SQRCP3	24 Apr 92	09:10:42
STAN1	Raw Trace	STAN''		12 Oct 91	00:44:03
STAN1	Point Data	STAN''		12 Oct 91	00:44:03
STEP_HEIGHT	Raw Trace	RL2		27 Apr 92	14:21:43

Fab : # Operation : #
Product : # Operator : #
Layer : # Lot # : #

F1:Delete F2:View F3:Export F4:Quit

Figure 12-19 Database Catalog

The following function keys are available in the Database catalog:

- [F1: Delete]: Deletes the item selected (see Section 12.3.5, "Deleting Data," for more information on this function).
- [F2: View]: Displays the data and trace (if any).
- [F3: Export]: Exports the selected item (see Section 12.3.4, "Exporting Data," for more information on this function).
- [F4: Quit]: Exits the Database catalog.

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4. Scroll up and down the Database catalog using [↑] or [↓], PAGE UP, PAGE DOWN, HOME, or END. Select the item to be recalled and press [F2: View] or ENTER to display the data and trace.

To recall data using default values:

The pound (#) symbol is used as the default value. You can use a combination of assigned values and the default value to list specific segments of the database.

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-13).
2. To enter the default value for a particular major or minor Data ID, use [↑] or [↓] to choose the Data ID and type #.

   Press [F1: Default] to enter default values for all the major and minor IDs except the last minor ID. Enter an assigned value or the wildcard (*) in the last minor ID.

   Note: You can change any of the default values to an assigned value. You also can specify values for data-dependent IDs. See "To recall data using assigned values" earlier in this section for more information on entering values for Begin Time and End Time.
3. When you are done entering the default value (or values) for the Data IDs, press ENTER to open the Database catalog (Fig. 12-19).
4. Scroll up and down the Database catalog using [↑] or [↓], PAGE UP, PAGE DOWN, HOME, or END. Select the item to be recalled and press ENTER to display the data according to type selected.

12.3.4 EXPORTING DATA

Use this option to export single file data in binary or ASCII format for use by other programs. Export data in binary format when exporting to another Tencor P-2 or to the Offline P-2 Program. Data exported in ASCII format can be read by standard spreadsheet and database manager programs.

> **NOTE:** **ASCII data cannot be manipulated directly by standard commercial programs. You will need to write macros that can manipulate the data in the receiving program.**

The Tencor P-2 software can be run in a Microsoft Windows 3.1 full-screen DOS window. A special format ASCII file can be generated for quick and easy data exchange with Windows-based spreadsheets or database managers. See Appendix C, "Exporting Data," for details.

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To export data:

Note: Each ID can be a combination of up to a maximum of 17 characters and numbers (no spaces allowed). When exporting data, the ID automatically gets truncated to the first eight characters. To export data with an eight-character name, enter an eight-character value when saving data or rename the data before exporting it.

1. Choose Disk Path from the Config menu and press ENTER to display the Disk Path window:

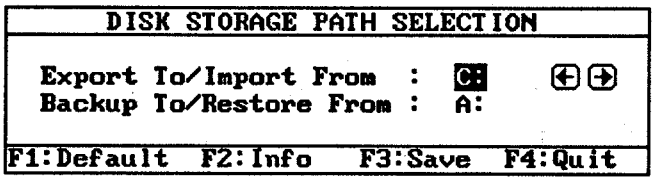


Figure 12-20 Selecting the Disk Path

2. Choose the drive to which the data will be exported and press [F4: Quit] to exit.
3. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-13).
4. Enter assigned values, default values, or wildcards for the major and minor Data IDs and press [F2: Recall] to display the Database Catalog window (Fig. 12-19).
5. Use [↑] or [↓] to choose the desired data item and press [F3: Export]. The following message is displayed:

   Export the data as BINARY [Y] or ASCII [N] file

6. To export ASCII characters, press NO. Note: Any key other than the YES key is considered NO. Refer to Appendix C, "Exporting Data," for the format of the exported data.
7. To export in binary format, press YES to display the Export Filename window:

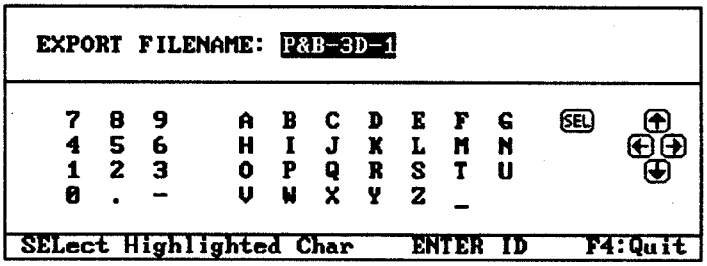


Figure 12-21 Entering the Export Filename

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8. Enter the export filename (a maximum of eight characters) and press ENTER to begin the export operation.

12.3.5 DELETING DATA

This section describes how to delete single data items. (To delete sections of the database, use the Purge function of the Maintain menu.) When you use the following method to delete raw data, you can delete the trace or the summary or both.

To delete data using the Database catalog:

1. Choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window (Fig. 12-13).
2. Enter assigned values, defaults, or wildcards for the major and minor Data IDs. You also can specify values for the data-dependent IDs. Press [F2: Recall] or ENTER to display the Database catalog (Fig. 12-19).
3. Choose the item to be deleted and press [F1: Delete]. The following message is displayed:

   Deleting Current Item 'P&B-3D-1,' Please Confirm. [Y/N]:

4. Press YES to confirm deletion or NO to return to the Database catalog without deleting the item. If you press YES and if you have selected a raw trace file type, the following message is displayed:

   Delete Entire Item [Y] or Raw Data Only [N]?

5. Press YES to delete the entire item or NO to delete the raw data only and save the summary.

12.4 MAINTAINING THE DATABASE

The database is maintained using the Maintain function in the Data menu of the menu bar. The Maintain function allows you to import, purge, back up, and restore the database. These functions are not intended for use on individual items but work on all items that match the Data IDs entered. For example, if you use the Purge function with all the IDs set to the wildcard, you will delete all the data except the recipes and Sequence programs in the database.

If you want to back up or restore single recipes and Sequence programs, use the Maintain functions under Recipe and Sequence of the menu bar. See Section 7.9, "Saving Data and Recipes," and Section 10.3, "Writing a Sequence Program," for more information on saving Scan recipes and Sequence programs respectively.

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To display the Data Maintenance window:

- Choose Maintain from the Data menu and press ENTER to display the following window:

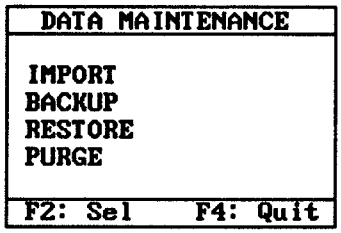


Figure 12-22 Data Maintenance Window

12.4.1 DATABASE CORRUPTION

Database corruption on your instrument is indicated by the following:

- The instrument displays error messages indicating database corruption. See Chapter 16, "Error Messages," for an alphabetical listing of all the error messages and their explanations.
- The recipe name has trailing spaces.

CAUTION: If the system displays messages indicating database corruption, proceed immediately with the database recovery procedures in Section 18.2.6, "Database Recovery." Failure to do so could result in the further corruption of the data and eventual loss of the entire installed database.

Database corruption is most likely to be caused by the following operations:

- Switching the power off or pressing RESET during a save operation.
- Saving or deleting items during the pause period of backup (provided to switch diskettes). In this case, the backed up data can become corrupted.
- Aborting a Restore function. This will fail to restore some of the raw data and "Item not found" messages will be displayed when the items are recalled from the catalog.

12.4.2 PURGING DATA

Use the Purge function to delete sections or single items of unwanted data from the database. You can enter assigned values, default values, or wildcards to identify data that is to be deleted.

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When you use the Purge function to delete raw data, both the trace and the summary are deleted. You do not have a choice of deleting either one as in the Delete function of the Database catalog.

To delete data:

1. Choose Maintain from the Data menu and press ENTER to display the Data Maintenance window (Fig. 12-22).
2. Use [↑] or [↓] to choose Purge and press ENTER to display the Database Purge IDs window:

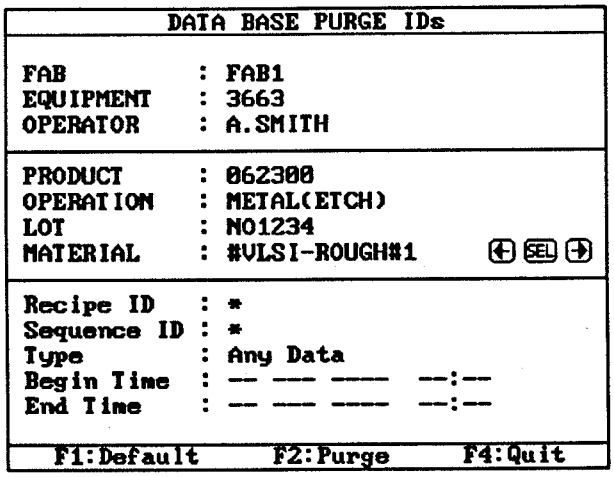


Figure 12-23 Database Purge IDs Window

- To enter assigned values, use [↑] or [↓] to select IDs and [←] or [→] to display assigned values.
- To delete sections of the database, use a combination of assigned values and defaults or assigned values and wildcards.
- Press [F1: Default] to enter the default symbol (#) in all the major and minor Data IDs except the last minor ID. To enter the default in the last minor ID, type # using the remote keyboard.

CAUTION: If you use wildcards (*) to identify data, your entire database will be deleted.

3. To specify the time limits for which the data will be deleted, use [↑] or [↓] to select Begin Time or End Time and press SEL. The following window is displayed for the Beginning Time Limit (Fig. 12-24):

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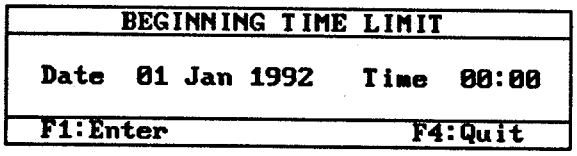


Figure 12-24 Specifying Beginning Time

The following window is displayed for the Ending Time Limit:

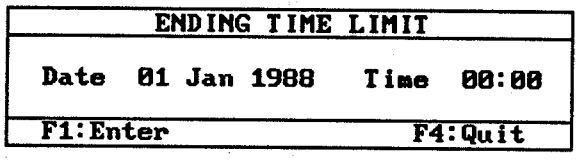


Figure 12-25 Specifying Ending Time

Use [←] or [→] to move between month, year, and time. Use [↑] or [↓] to display the desired date, month, and time. Press [F1: Enter] to enter the time limit.

4. Press [F2: Purge] to delete the selected data.

   - If you selected the entire data base by using wildcards, the following warning message is displayed:

     All data will be permanently eliminated from the data base. Do you really want to do this? [Y/N]:

     If you press YES, you will receive a second warning:

     Again, just to be sure, do you really want to eliminate all the data in the data base? [Y/N]:

CAUTION:	If you are sure that you want to delete the entire database, press YES to the previous warning. The entire database is deleted.

   - If you selected sections of the database to delete, the following message is displayed:

     This will permanently eliminate selected items, OK? [Y/N]:

     Press YES to delete the selected data or NO to return to the Database Purge IDs window without deleting the selected data.

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12.4.3 IMPORTING DATA

Use the import function to import binary data from another database or instrument. See Section 5.5.1, "Importing Recipes," and Section 10.9.3, "Importing Sequence Programs," for details on importing Scan recipes and Sequence programs respectively.

> **NOTE:** **You can import data in binary format only. Data exported in ASCII format cannot be imported back into the database.**

To import data:

1. Insert the diskette from which data is to be imported in drive A.
2. Change the backup disk path to A. See Section 7.9, "Saving Data and Recipes," for more information on changing the disk path.
3. Choose Maintain from the Data menu and press ENTER to display the Data Maintenance window (Fig. 12-22).
4. Use [↑] or [↓] to choose Import and press ENTER to display the following window:

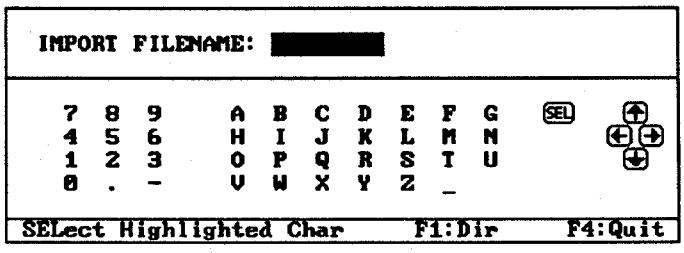


Figure 12-26 Entering the Import Filename

5. Type the name of the file to be imported and press ENTER, or
   Press [F1: Dir] to display a directory of the data files available for import (Fig. 12-27):

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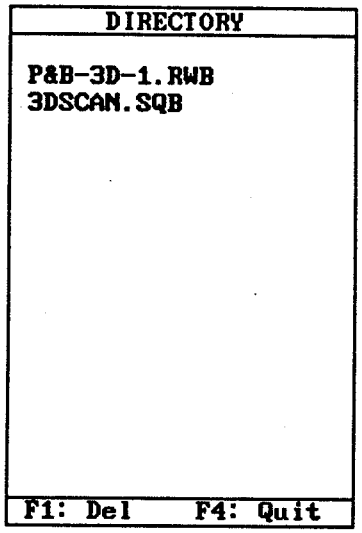


Figure 12-27 Directory of Files Available for Import

6. Use [↑] or [↓] to choose the file to be imported and press ENTER to import the file.

12.4.4 BACKING UP DATA

The Backup function is intended to be used as a safety measure.

NOTE:	Back up your hard drive weekly if the instrument is being used intensively every day. New recipes, Sequence programs, and data also should be systematically backed up. See Section 5.5.2, "Backing Up and Restoring Recipes," and Section 10.9.4, "Backing Up Sequence Programs," for more information.

Backing up will ensure that you can restore the database in case the database gets corrupted. Use this function to back up your entire hard drive to 3.5-in. diskettes. You also can transfer selected data to be analyzed in an offline program.

To back up data:

NOTE:	No incremental backups are allowed. In other words, once you have ended the backup session, you cannot add to the last backup diskette.

1. Format several 3.5-in. diskettes. See Section 18.3.1, "Formatting Diskettes," for more information.

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2. Change the backup disk path to drive A. See Section 7.9, "Saving Data and Recipes," for more information on changing the disk path.
3. Choose Maintain from the Data menu and press ENTER to open the Data Maintenance window (Fig. 12-22).
4. Choose Backup and press ENTER. The following message is displayed:

   Back up everything in the data base? [Y/N]:

5. If you press NO, the Database Backup IDs window is displayed:

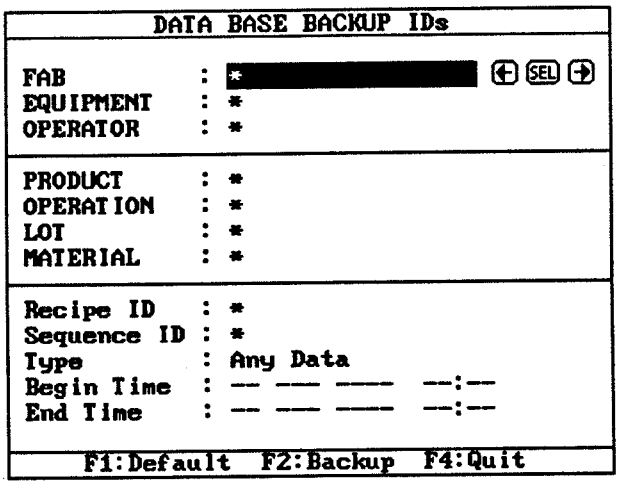


Figure 12-28 Database Backup IDs Window

Enter values to select data to be backed up and press [F2: Backup].

6. If you press YES or after you have selected data to be backed up, the following message is displayed:

   Please insert backup volume 1
   Press any key to continue

7. Insert the backup disk in the external drive and press any key to continue.
8. When the backup disk is full, the system displays the following message:

   No More Usable Space on Backup Volume.
   Try Another [Y] or Suspend the Session [N]?

9. Insert another backup diskette or press NO to suspend the backup session. You can suspend the backup function indefinitely if you do not have enough formatted diskettes to back up the database.

   Note: If you select the Backup function again after the function was suspended, the system displays a prompt asking if you want to resume the Backup function. Press YES to resume the Backup function.

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> **CAUTION:** **Do not save or delete data after suspending and before resuming the backup as you might corrupt the database.**

12.4.5 RESTORING DATA

Use the Restore function to restore data from backup devices to the database in the Tencor P-2. Restoring data is a very time-consuming process and depends on the nature of data being restored and the number of backup diskettes. As a rule, allow at least 1 hour per backup diskette.

> **CAUTION:** **Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."**

To restore data:

1. Choose Maintain from the Data menu and press ENTER to open the Data Maintenance window (Fig. 12-22).
2. Choose Restore and press ENTER to display a message similar to the following:

   Approximate restoration capacity is 5.0
   high-density diskettes. OK to Restore? [Y/N]:

   The above message will indicate how much data you can safely restore. According to the above sample message, you can restore data from five high-density diskettes to your hard drive. If you have more data to restore than space available on your hard disk, delete some of the data on your hard disk. See Section 12.4.2, "Purging Data," for details on deleting data.
3. Press YES to display the following message:

   Restore everything found in backup files? [Y/N]:
4. If you want to restore all the data in the backup files, press YES. To restore sections of the database, press NO to display the Database Restore IDs window (Fig. 12-29):

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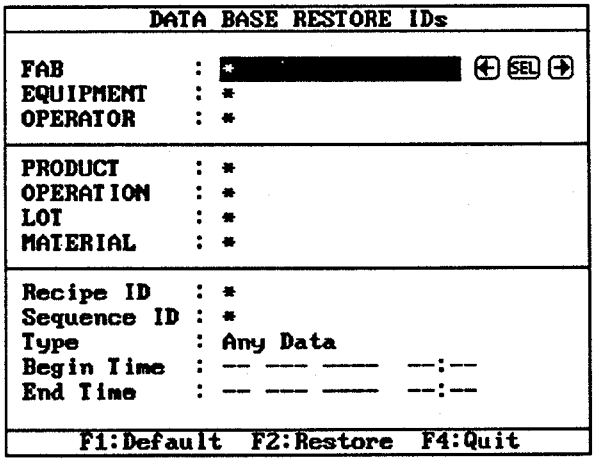


Figure 12-29 Database Restore IDs Window

Enter values, defaults, or a combination of values and defaults to select data to be restored.

5. If you pressed YES to restore the entire database, or entered the desired Data ID values and pressed [F2: Restore] in the Database Restore IDs window, the following message is displayed:

   Please insert backup volume 1
   Press any key to continue

6. Insert the backup disk and press any key to begin restoring data. When all the data on the disk has been restored to the hard drive, the following message is displayed:

   End of Backup Volume.
   Continue with Next Volume [Y] or Abort [N]?

CAUTION:	Aborting the restore process will terminate the operation and not suspend the function indefinitely as happens with backup. Aborting the restore process before the data has been completely restored will cause error messages when recalling the data.

7. To continue with restoring data, press YES, insert the next diskette to be restored, and press ENTER. Continue to insert backed up diskettes until all the data has been restored.

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DATABASE MANAGER TUTORIAL

INTRODUCTION

This tutorial is provided so that you can become familiar with the basic aspects of the Database Manager. Use the tutorial to practice recalling, displaying, and purging from a sample collection of data. You can set up the tutorial session using the sample data provided on the sample data diskette.

This tutorial assumes that you are familiar with the basic concepts of the Tencor P-2 software such as the main menu bar, the components of each menu of the main menu bar, taking scans, etc.

Keep in mind that this tutorial covers only some of the basics of the Database Manager Option. Refer to Chapter 12, "Database Manager Option," for detailed information.

HOW THE DATABASE MANAGER WORKS

Each item of data is saved using seven classes of user-configurable IDs (the first seven IDs in Fig. T-1) in the database. Of these seven IDs, the first three IDs are the major IDs and the next four are the minor IDs. The remaining IDs (if any) are the data-dependent IDs. Each type of ID is explained below.

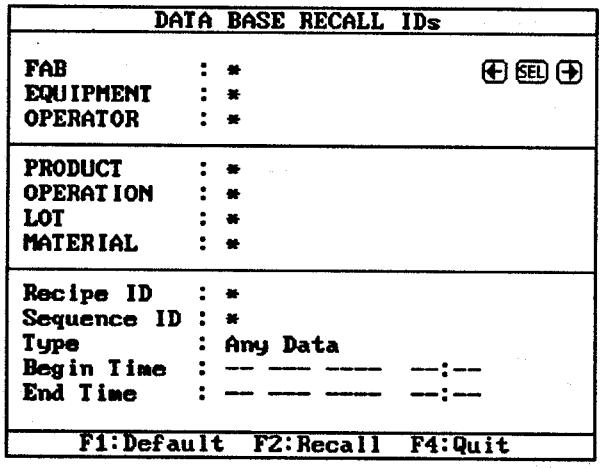


Figure T-1 Major and Minor IDs

Major IDs: The first three IDs (Fab, Equipment, and Operator in the above figure) are the major Data IDs. These must have values attached to them before you save single scan data. Sequence or recipe data provide the three major Data ID values from the sequence or recipe settings.

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Minor Data IDs: The next four IDs (Product, Operation, Lot, and Material in Fig. T-1) are the minor Data IDs. These IDs also must have values attached to them before you can save single scan data.

Data-Dependent IDs: The last five IDs (Recipe ID, Sequence ID, Type, Begin Time, and End Time in Fig. T-1) are the data-dependent IDs. Each of the Data IDs is explained below:

- *Recipe ID* is the name of the generating recipe.
- *Sequence ID* is the name of the generating sequence (if any).
- *Type* has six preset values: raw trace, point data, sequence results, 3-D data, and any data. Statistics data is supplied within sequence results.
- *Begin Time* selects items after this time only.
- *End Time* selects items until this time only.

The labels identifying the Data ID categories are set up prior to data collection. Labeling Data ID categories is an administrative function and is protected by a password.

Data is saved, recalled, or exported using assigned values, wild cards, or default values.

Assigned Values: Data is saved using these values and you can save, recall, or export specific items of data using the attached values.

Default Values: The pound (#) symbol is used as a default value in the Tencor P-2 database. When saving data, use the default value for any of the Data IDs when you do not want to use any particular value.

Wildcards: The star (*) symbol is used as a wildcard. Use this symbol when recalling data to list all the data in the Database catalog.

SETTING UP THE PRACTICE SESSION

Set up the tutorial session using the directions provided below. Load (restore) the sample data provided on the sample data diskette into the Tencor P-2 database. The sample data will be used in the lessons in the following sections of this tutorial. A data branch labeled TUTOR will be set up in the database when the tutorial data is installed.

You also will need to provide the trainee with a minimum of two blank, formatted, 3.5-in. diskettes.

To load data into the tutorial session:

1. From the menu bar, choose Maintain from the Data menu and press ENTER to display the Data Maintenance window (Fig. T-2).

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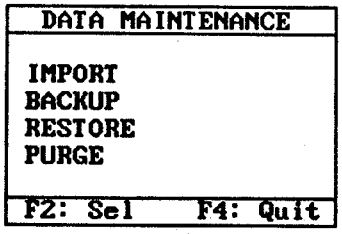


Figure T-2 Data Maintenance Window

2. Use [↑] or [↓] to choose Restore and press ENTER. A message is displayed showing the amount of data to be restored and asks if you wish to restore the data.

   Press YES to display the following message:

   Restore everything found in backup files? [Y/N]:

3. Press YES to restore the entire tutorial session to your hard drive. The following message is displayed:

   Please insert backup volume 1
   Press any key to continue

4. Insert the sample data diskette in drive A and press any key to continue.

5. To return to the menu bar at any time, press MENU.

To check that the tutorial data has been loaded into the database:

1. From the menu bar, choose Catalog from the Data menu and press ENTER to display the Database Recall IDs window:

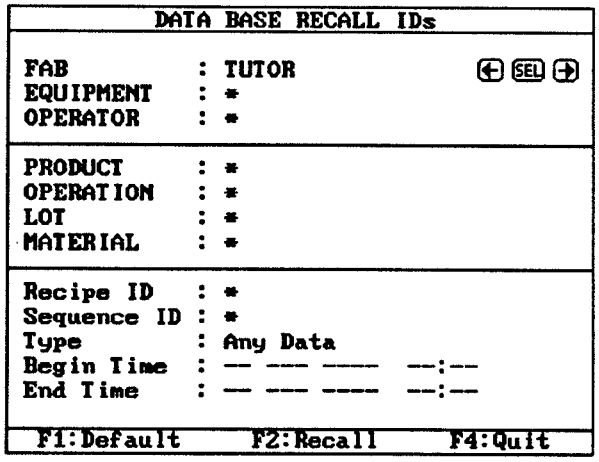


Figure T-3 Checking if the Training Data is Loaded

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2. Type *tutor* in the first major ID (FAB in Fig. T-3) and press DELETE or CLEAR in each of the next eight IDs to enter the wildcard (*).

3. Use [↑] or [↓] to choose Type. Use [←] or [→] to select Any Data and press ENTER to display the Database catalog. Fig. T-4 below is a sample Database catalog.

DATA BASE CATALOG

SLOT NUMBER	Item Type	Recipe ID	Sequence ID	Date	Time
3-D/STYLUSTEST	3-D Scan	3-D/STYLUS		20 Apr 92	14:03:47
3DSEQTST	Seq Results		3DSEQTEST	22 Jan 92	14:05:37
3IN5PT-1A	Seq Results		3IN5PT-1	01 May 92	13:58:21
3INTEST	Raw Trace	3INSTRESS		07 Apr 92	11:02:11
3INTEST-P	Raw Trace	3INSTRESS		07 Apr 92	14:34:28
4	Seq Results		SQRCP2SEC	12 Jan 92	13:47:26
941A-STD-1	Seq Results		941A-STD	01 May 92	13:52:29
ACUSHNET	3-D Scan	GOLFBALL		25 Apr 92	15:16:06
MULT-ANA-M	Seq Results		MULT-ANA-M	28 Apr 92	16:53:48
SCAN-N-K	Raw Trace	SCAN-N-K13		25 Jan 92	14:08:23
SCAN-N-K	Point Data	SCAN-N-K13		25 Jan 92	14:08:23
SPR	Raw Trace	SPR-2		16 Apr 92	14:28:52
SQRCP3-1	Seq Results		SQRCP3	24 Apr 92	09:10:42
STAN1	Raw Trace	STAN"		12 Oct 91	00:44:03
STAN1	Point Data	STAN"		12 Oct 91	00:44:03
STEP_HEIGHT	Raw Trace	RL2		27 Apr 92	14:21:43

Fab : * Operation : *
Product : * Operator : *
Layer : * Lot * : *

F1:Delete F2:View F3:Export F4:Quit

Figure T-4 Sample Database Catalog

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LESSON 1: ADDING AND DELETING ID VALUES

This lesson covers adding and deleting ID values. To change the ID labels see Section 12.2.1, "Setting Major and Minor Data ID Labels," for more information.

We recommend that only supervisors add and delete ID values and change ID labels.

To add and delete ID values:

1. From the menu bar, choose Catalog from the Data menu and press ENTER to display the following window:

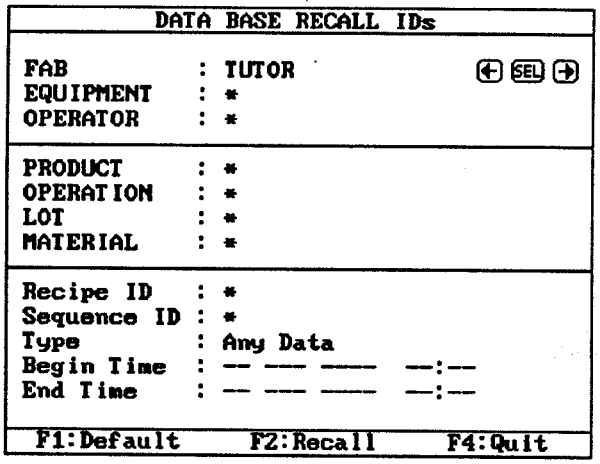


Figure T-5 Database Recall IDs Window

2. Use [↑] or [↓] to choose the first major ID (Fab in the above figure) and type *tutor*. Use [↓] to move to the second major ID (Equipment in the above figure), and press SEL on the built-in keyboard or the spacebar on the extended keyboard. A window listing all available values for that particular data ID is displayed (Fig. T-6).

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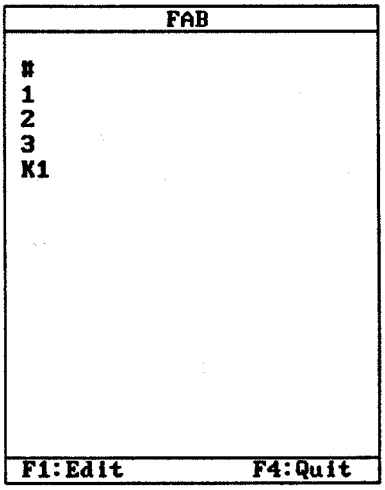


Figure T-6 ID Values List

4. Press [F1: Edit] to open the Value Editing window, similar to the one displayed below.

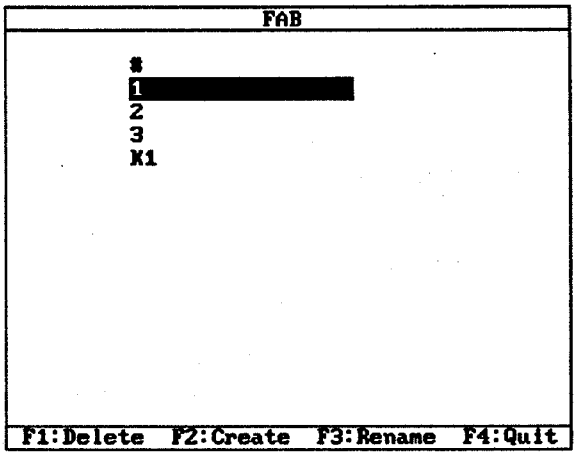


Figure T-7 Editing ID Values

5. Press [F2: Create] to open the Create ID window. Type *test1* and press ENTER. You will see that the Value Editing window (Fig. T-7) now displays a new value, Test1.
6. Repeat step 5 twice and create values *test2* and *test3*.
7. Choose test1 and press [F1: Delete]. You will see that the Value Editing window no longer displays the test1 value.
8. Choose a value other than the value you have created and press [F1: Delete]. The system will display a message that you cannot delete values that have lower-level IDs or data attached to them.

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LESSON 2: SAVING DATA

In the keylock 1 or 2 position, you are restricted to entering values for only those major or minor Data IDs that have the wildcard (*). There are no restrictions on entering new or assigned values in the keylock 3 position.

To save data:

1. Take a scan (see Chapter 6, "Profiling a Sample," for information on taking a scan) and press [F2: Save]. The Database Save IDs window below is displayed.

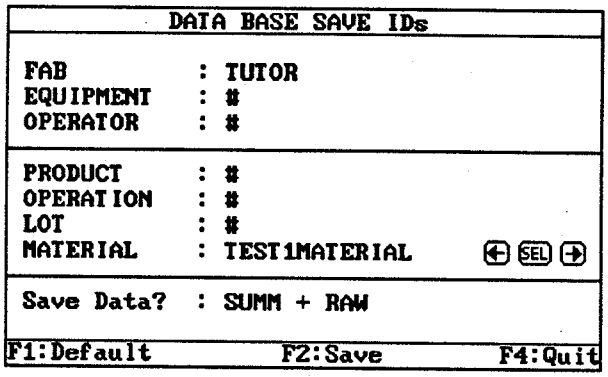


Figure T-8 Database Save IDs Window

2. Type *tutor* in the first major ID (Fab in the above figure) and # in the next five IDs. Type *test1material* in the seventh ID (Material in the above figure).

   To use assigned values, use [↑] or [↓] to choose the ID and press SEL on the built-in keyboard or the spacebar on the remote keyboard. The Value ID List window (Fig. T-6) listing all available values for that particular data ID is displayed. Use [↑] or [↓] to select any of the values and press ENTER to enter the value for the ID.

   Note: Use assigned values under the TUTOR database branch only.

3. When done entering values for all major and minor Data IDS, press [F2: Save] to save the scan and data.

   See Section 12.3.1, "Saving Data without Assigned Values," and Section 12.3.2, "Saving Data with Assigned Values," for more information on saving data using wildcards and default values.

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LESSON 3: RECALLING DATA

Data can be recalled using known values, wildcards, or default values for the selection criteria. See Section 12.1.1, "How the Database Works," for more information on known values, default values, and wildcards.

To recall data using known values:

1. From the menu bar, choose Catalog from the Data menu and press ENTER. The Database Recall IDs window is displayed (Fig. T-5).
2. Type *tutor* for the first major ID and press DELETE or CLEAR in each of the next six IDs to enter the wildcard (*).
3. Use [↑] or [↓] to choose Type. Use [←] or [→] to select Any Data and press [F2: Recall]. The Database catalog, listing all the data saved under TUTOR, is displayed (Fig. T-4).
4. Select any of the data and press [F2: Recall] to display the data and trace.
5. To return to the menu bar, press ESC.

LESSON 4: EXPORTING DATA

You will need a blank, formatted, 3.5-in. diskette to export data. The Export function allows you to export data in ASCII or binary format so that the data can be read, after macro processing, by standard spreadsheet and database programs.

To export data:

1. Insert the blank, formatted diskette into the external disk drive A.
2. From the menu bar, choose Disk Path from the Config menu and press ENTER to display the following window:

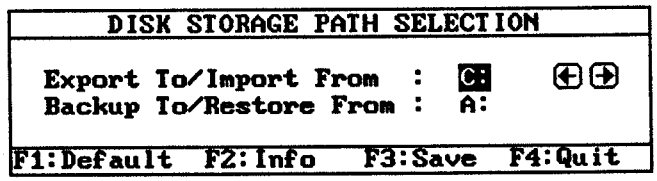


Figure T-9 Disk Storage Path Selection Window

3. In the Export To/Import From field use [←] or [→] to choose A. Press [F4: Quit] to close the window.
4. From the menu bar, choose Catalog from the Data menu and press ENTER to open the Database Recall IDs window (Fig. T-5).

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5. Type *tutor* for the first major ID, and press DELETE or CLEAR in each of the next six IDs to enter the wildcard (*).
6. Use [↑] or [↓] to choose Type. Use [←] or [→] to select Any Data and press [F2: Recall]. The Database catalog, listing all the data saved under TUTOR, is displayed (Fig. T-4).
7. Use [↑] or [↓] to choose any item and press [F3: Export]. You will be prompted if data should be exported in binary or ASCII format. Press YES to export the selected data in binary format or press NO to export the file in ASCII format.

   Note: Any key other than the YES key will be considered NO.
8. When you are done exporting data and the message "Exporting Data" disappears, press MENU to return to the main menu bar.

LESSON 5: BACKING UP DATA

In this lesson, you will back up all the tutorial data onto a blank, formatted, 3.5-in. diskette. The Backup function is intended to be used as a safety measure. You can back up your entire database or you can transfer selected data to the Offline Tencor P-2 program. See Chapter 15, "Offline P-2 Program," for more information.

To back up data:

1. From the menu bar, choose Maintain from the Data menu and press ENTER to open the Data Maintenance window (Fig. T-2).
2. Choose Backup and press ENTER. You will be asked if you want to back up everything in the database. Press NO.
3. The Database Backup IDs window is displayed:

```
DATA BASE BACKUP IDs

FAB          : TUTOR                    ◄ SEL ►
EQUIPMENT    : *
OPERATOR     : *

PRODUCT      : *
OPERATION    : *
LOT          : *
MATERIAL     : *

Recipe ID    : *
Sequence ID  : *
Type         : Any Data
Begin Time   : -- --- ----  --:--
End Time     : -- --- ----  --:--

F1:Default   F2:Backup   F4:Quit
```

Figure T-10 Database Backup IDs Window

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Type *tutor* in the first major ID (FAB in the figure below) and press DELETE or CLEAR in each of the next eight IDs to enter the wildcard (*).

4. Use [↑] or [↓] to choose Type. Use [←] or [→] to select Any Data and press [F2: Backup].
5. The system will instruct you to insert the first backup diskette. Insert the blank, formatted, 3.5-in. diskette into the drive A and press ENTER.

LESSON 6: DELETING DATA

There are two ways of deleting data from the database depending on the amount of data you want to delete. Single data items can be deleted from within the Database catalog (Fig. T-4); multiple items or the entire database should be deleted using the Purge function in the Data Maintenance menu (Fig. T-2). Lesson 7 will show you how to delete all the tutorial data from the database.

Note: You have the option of deleting the entire item or deleting the raw data only and saving the summary.

To delete a single item of data:

1. From the menu bar, choose Catalog from the Data menu and press ENTER. The Database Recall IDs window is displayed (Fig. T-5).
2. Type *tutor* for the first major ID (Fab in Fig. T-5) and press DELETE or CLEAR in each of the next eight IDs to enter the wildcard (*).
3. Use [↑] or [↓] to choose Type. Use [←] or [→] to select Any Data and press [F2: Recall]. The Database catalog, listing all data saved under TUTOR, is displayed (Fig. T-4).
4. Use [↑] or [↓] to choose any one item and press [F1: Delete]. A message, similar to the one below, is displayed:

   Deleting Current Item 'P&B-3D,' Please Confirm. [Y/N]:

5. Press YES to confirm deletion. If you press YES and if you have selected a raw trace file type, the following message is displayed:

   Delete Entire Item [Y] or Raw Data Only [N]?

6. Press YES to delete the entire item.
7. When you are done deleting data, press ESC to return to the menu bar.

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LESSON 7: PURGING DATA

Purge should be used to delete multiple items of data. When you use the Purge function to delete raw data, both the trace and the summary are deleted. You do not have a choice of deleting only one or the other as in the Delete function of the catalog.

To delete data:

1. From the menu bar, choose Maintain from the Data menu and press ENTER to display the Data Maintenance window (Fig. T-2).
2. Use [↑] or [↓] to choose Purge and press ENTER to display the Database Purge IDs window similar to the one displayed below.

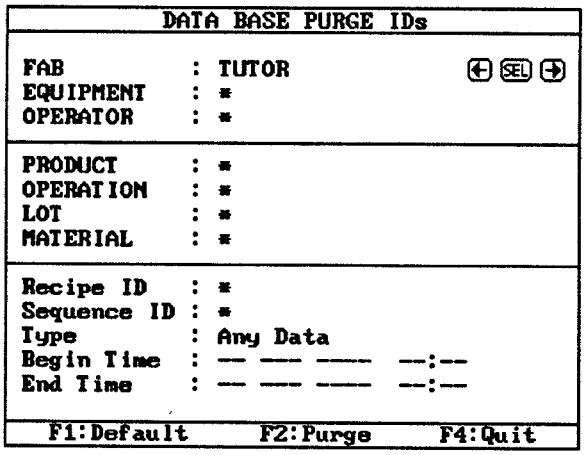


Figure T-11 Deleting Multiple Items of Data

3. Type *tutor* for the first major ID (Fab in the above figure) and press DELETE or CLEAR in each of the next eight IDs to enter the wildcard (*).

> **CAUTION:** **If you enter * for the first major ID, your entire database will be deleted.**

4. Use [↑] or [↓] to choose type. Use [←] or [→] to select Any Data and press [F2: Purge].
5. The system displays a warning that all the selected data will be deleted permanently from the database. Press YES.

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Note: A Scan recipe and Sequence program named TUTOR are also loaded with the tutorial data. See Section 5.3, "Setting Scan Parameters," and Section 10.3, "Writing a Sequence Program," for more information on deleting Scan recipes and Sequence programs respectively.

6. Press ESC to return to the menu bar.

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13 WAFER STRESS OPTION

13.1 OVERVIEW

It is important to monitor thin film stress as thin film stress data can be used to reduce process variations. Stress is generated in the film and substrate during thin film deposition. The deformation of the thin film can be accommodated by the bending and compressing or expanding (depending on the curvature) of the substrate.

With the Wafer Stress Option, the Tencor P-2 can determine the stress levels in a deposited film by measuring the deflection or curvature that the stress induces in the substrate. The program determines the curvature of the sample by calculating the least square fit of the trace data to a circle. The equation for stress is as follows:

$$\sigma = \frac{1}{6R} \frac{E}{(1-v)} \frac{t_s^2}{t_f}$$

where:

$\frac{E}{(1-v)}$ = substrate elastic constant
t_s = substrate thickness
t_f = film thickness
R = radius of curvature

The program calculates the radius of curvature by using a least squares fit method.

Note: You can verify the program results by using the following equation for radius of curvature [R]:

$$R = \frac{L^2}{8B} \text{ if } L >> B$$

where:

B = bow (maximum between trace and its chord)
L = chord length (scan length)

Note: All geometric dimensions are in the same units.

The Tencor P-2 program calculates the following stress values:

- Average Stress derived from the least square fit of the entire profile
- Maximum Stress based on the maximum of 13 overlapping sections of one-third of the length and offset across the total profile
- Center Stress computed at the center third of the profile

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13.1.1 USING THE WAFER STRESS OPTION

Use the Wafer Stress Option to compare pre- and postprocessing traces. This comparison calculates the curvature caused solely by the processing-induced stress. This measurement is referred to as a difference measurement.

You also can take a single stress measurement without comparing it to an earlier measurement. This is a poststress-only measurement and is used when you have no prestress data for a wafer. See Fig. 13-1 and Fig. 13-2 for flowcharts showing the sequence of difference and poststress-only measurements.

- Taking a difference measurement involves scanning the sample in Single Scan mode before the sample is processed. (For details see Section 13.3, "Taking a Difference Measurement.") The resulting trace is prestress data. After processing, display the Stress screen, enter the ID of the prestress wafer, and rescan the sample. *Make sure that you scan the same part of the sample as before and use the same recipe.* The program compares the data in the post- and prestress scans and displays the results.
- To take a poststress-only measurement, display the Stress screen, enter a new ID, and scan the sample. (For details see Section 13.4, "Taking a Single, Poststress Measurement.") *When taking a poststress-only measurement, the program assumes that the sample is perfectly flat prior to exposure to the stress-inducing process.*
- You can take stress scans in the Single Scan mode only; you *cannot* take stress scans with a sequence.
- Only the pre- and poststress traces and summaries are saved. Stress values are not saved but recalculated each time from the raw traces. To recalculate the stress values, both the pre- and poststress traces must be present in the Data catalog.

13.1.2 ENTERING AN ID

Entering the appropriate ID after you display the Stress screen is critical as the program decides which type of measurement to take depending on the ID.

- If you enter the ID of an earlier scan, the program assumes that the earlier scan is prestress data for a stress comparison.
- If you enter a new ID, the program will give you a single, poststress measurement because it does not have an earlier scan to use in a comparison.
- For stress measurements, Part ID is now labeled Wafer ID.

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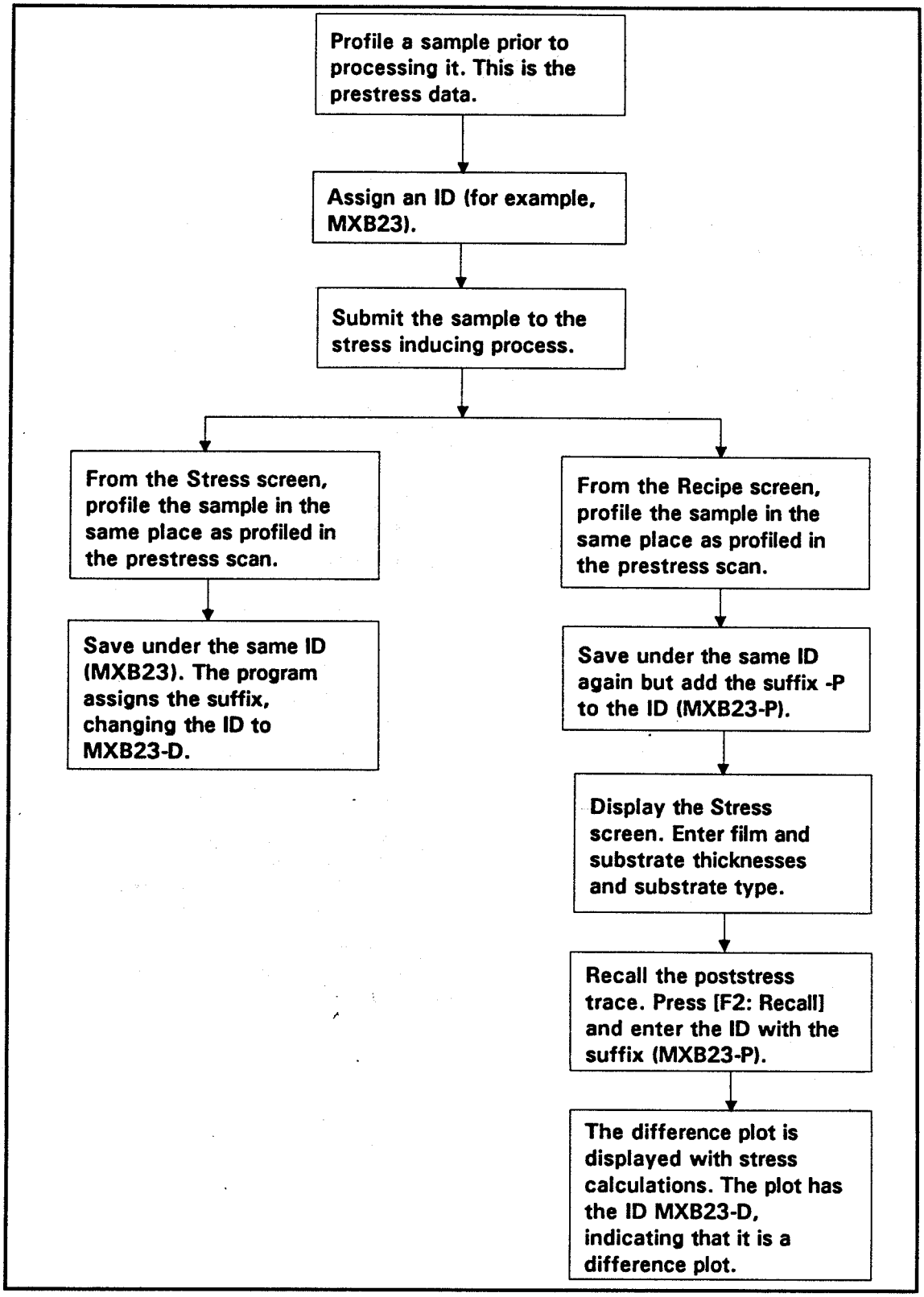


Figure 13-1 Taking a Difference Measurement

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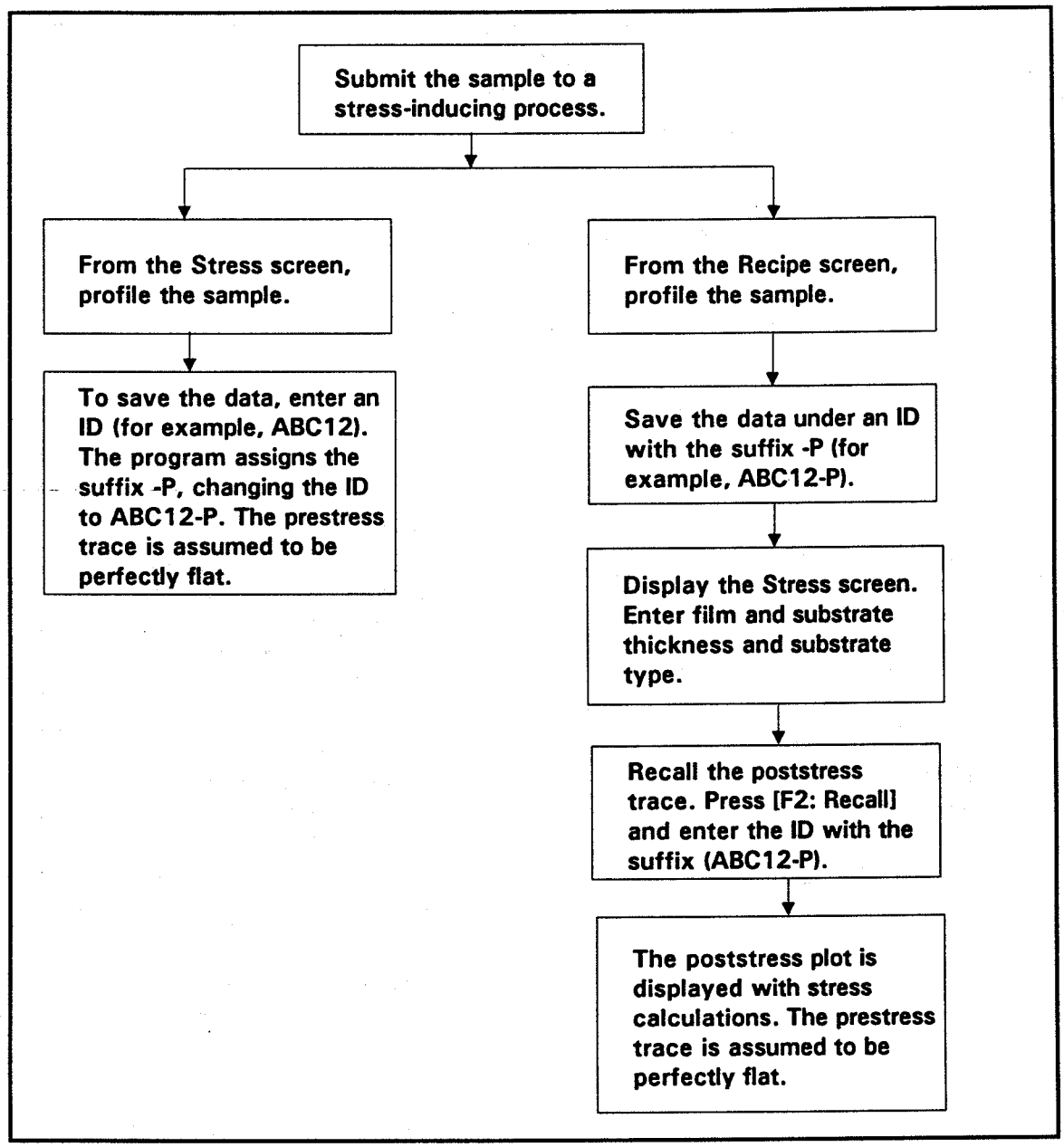


Figure 13-2 Taking a Poststress-Only Measurement

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13.1.3 ADDING AN ID SUFFIX

To help keep track of the type of stress measurement that a scan represents, the program automatically adds a suffix to the Wafer ID when it displays the measurements on screen. Poststress-only measurements have the suffix -P; difference measurements have the suffix -D. Prestress measurements are generated outside the Stress screen of the Wafer Stress Option and are identified without a suffix.

For example, save a prestress scan with the Wafer ID MXB23. After processing, display the Stress screen, enter the MXB23 ID, and scan the sample again. After the scan, the program displays a trace with the Wafer ID MXB23-D showing that the difference measurement has been computed and is displayed. See Fig. 13-1 for a flowchart on taking a difference measurement.

On the other hand, suppose that you have no prestress scan for ABC12. When you take the stress measurement, enter ID ABC12. The program changes the ID to ABC12-P, indicating the trace to be a poststress trace. In this case, the prestress trace is assumed to be perfectly flat. See Fig. 13-2 for a flowchart on the sequence of poststress measurements. The chart also outlines the assignment of IDs.

13.1.4 SAVING DATA

To recompute and display difference measurements, both pre- and poststress raw and summary data must be saved. Also, saving the raw and summary data will allow you to recalculate the stress value with different parameters. Note, however, that saving raw data takes up significantly more space (4 bytes per data point rounded to the nearest 2048) on the hard disk.

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13.2 TAKING A PRESTRESS SCAN

Prestress data displays a profile of the sample before the sample is stressed by processing. The data establishes a baseline for later comparisons.

13.2.1 SELECTING A SCAN RECIPE

To choose a Scan recipe:

1. Press MENU.
2. Choose Catalog from the Recipe menu and press ENTER to display the Recipe Catalog window (Fig. 5-2).
3. Use [↑] or [↓] to select a recipe and press [F2: Recall] to display the recipe. To create a new recipe, see Section 5.3, "Setting Scan Parameters."
4. Press [F4: Quit] to exit the Recipe window.

13.2.2 LOADING AND POSITIONING THE SAMPLE

NOTE:	**If you are using the wafer handler to load wafers, make sure the wafer stress chuck is installed on the stage before starting stress measurements. See below for details.**

TENCOR P-2 HANDLER WAFER STRESS CHUCK

The wafer stress chuck (Fig. 13-3) is designed to support the wafer during wafer stress measurements. The instrument is shipped with the vacuum chuck installed if your instrument comes with the wafer handler. To replace the vacuum chuck with the wafer stress chuck, use the instructions provided in Section 2.2.6, "Installing a Precision Locator."

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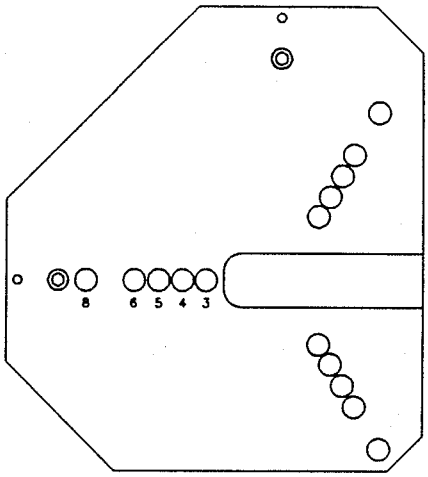


Figure 13-3 Handler Wafer Stress Chuck

The handler controls the placement of the wafer by centering it on the locator. The three wafer support pins can be located for wafers of nominal sizes 3 to 8 in.

For information on loading and positioning the sample, refer to Section 6.3, "Loading the Sample," and Section 6.4, "Viewing and Positioning the Sample."

- If the wafer is loaded using the wafer handler, make sure the wafer is loaded using the aligner. Also the angle used for alignment must be the same for the prestress and poststress loading.
- If the sample is loaded manually, note the position of the sample when you load it on the stage table. To compare pre- and poststress measurements, you must duplicate this scan position for the poststress measurement.
- Load a sample for which you already have saved a recipe. Otherwise, use the default recipe, P2, or create a recipe. See Chapter 5, "Writing a Recipe," for instructions on creating recipes.

13.2.3 PROFILING THE SAMPLE

To take a prestress scan and save the data:

NOTE:	Do not take the prestress scan in the Stress screen of the Wafer Stress Option.

1. Press START. The Scan screen (Fig. 6-30) is displayed during the scan. After the scan is completed, the Data screen (Fig. 7-1) is displayed with the trace.

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2. Press [F4: Save] to save the prestress data:

   - If the Database Manager Option is not installed, the Alphanumeric window is displayed (Fig. 3-13) with the default ID, which in this example is MXB23. Notice that the ID has no suffix, indicating that the scan is prestress data. Press ENTER to save the prestress scan. The following message is displayed:

     Save Raw Data + Summary [Y] or Summary Only [N]?

     Press YES to save both the raw data (trace) and the Summary screen.

   - If the Database Manager Option is installed, the following window is displayed:

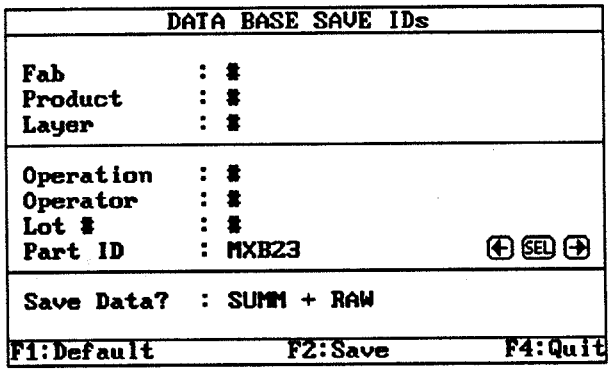


Figure 13-4 Saving Prestress Data

Note: The database should be configured before you start saving data. See Section 12.2, "Configuring the Database," for more information.

- Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs.
- You also can enter new values for the IDs. Each ID value can be a combination of up to a maximum of 17 characters and numbers (*no spaces allowed*). Note: When exporting data, the ID will automatically get truncated to the first 8 characters.
- Press [F1: Default] to save data using # as an identifier in the first six IDs (Fab, Equipment, Operator, Product, Operation, and Lot in Fig. 13-4).
- Enter the Wafer ID for the seventh ID (Part ID in Fig. 13-4).
- Use [←] or [→] to select both the Summary and Raw Data.
- When done entering values for the IDs, press ENTER to save the data.

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13.3 TAKING A DIFFERENCE MEASUREMENT

A difference measurement compares the stress data in the current trace with prestress data from an earlier scan. Therefore, you will need a processed sample that was scanned before processing. Make sure that the preprocessing scan is listed in the Data catalog.

The poststress scan should be done in the Stress screen of the Wafer Stress Option.

> **NOTE:** **If prestress raw data (trace) has not been saved before computing a difference measurement, the difference measurement is not computed, and the poststress trace is displayed.**

13.3.1 SELECTING A SCAN RECIPE

To choose a Scan recipe:

> **NOTE:** **You must select the same recipe that was used for the prestress scan.**

1. Press MENU.
2. Choose Catalog from the Recipe menu and press ENTER to display the Recipe Catalog window (Fig. 5-2).
3. Press [↑] or [↓] to select the recipe that you used for the prestress scan.
4. Press [F2: Recall] to display the recipe in the Recipe window.
5. Press [F4: Quit] to exit the Recipe window.

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13.3.2 LOADING AND POSITIONING THE SAMPLE

For information on loading and positioning the sample, refer to Section 6.3, "Loading the Sample," and Section 6.4, "Viewing and Positioning the Sample." Before loading a sample, check that it meets the following requirements:

- The sample has been processed.
- It was scanned before the processing.
- The scan is in the database.

To position the sample for a difference measurement:

NOTE:	Position the sample exactly as it was positioned for the prestress scan.

1. If you are loading the sample manually, use the wafer stress precision locator, that is, the locator with the three support points. Be sure that you position the sample the way it was positioned for the prestress scan.

   The precision locator has fittings that locate wafers of various sizes in X, Y, and Θ. It supports the wafers in a way that minimizes gravitational distortions but also ensures that the residual gravitational distortion is the same for both the pre- and poststress scans.

   If you are loading the wafer using the wafer handler, you must load the wafer using the aligner. Also, use the same angle for alignment in prestress and poststress loading.

2. You can program the instrument so that the load position moves the stage to exactly the right scan position. (See Section 6.3, "Loading the Sample.")

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13.3.3 ENTERING STRESS PARAMETERS

To enter stress parameters:

1. Choose Stress from the Analysis menu and press ENTER to display the Stress screen:

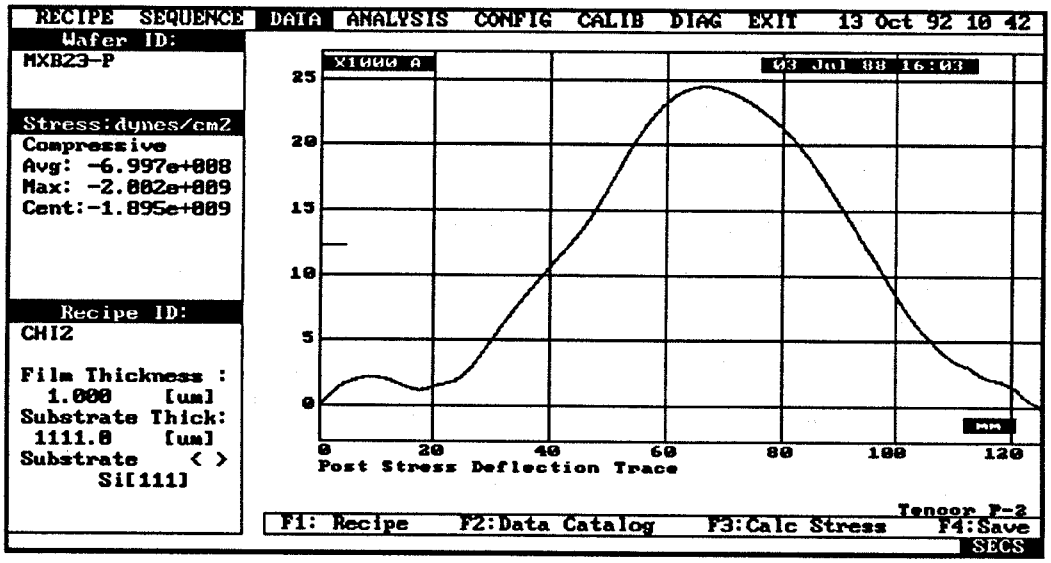


Figure 13-5 Stress Screen

2. In the Film Thickness field, type the thickness (in μm) of the film on the sample and press ENTER.
3. The highlight moves to the Substrate Thickness field. Enter the thickness of the substrate (in μm) and press ENTER.
4. The highlight moves to the Substrate field. You have the choice of selecting a predefined substrate or entering a user-defined elastic constant:
   - To select a predefined elastic constant, press [←] or [→] to select the desired substrate with its elastic constant. Table 13-1 lists the available substrates and their elastic constants.
   - To enter a user-defined elastic constant, press [←] or [→] until Other is selected in the Substrate field. A field appears below the Substrate field allowing you to type in the desired value.

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Table 13-1 Elastic Constants for Commonly Used Thin Film Substrates

Material	Orientation	Elastic Constants (dynes/cm^2)
Aluminum	*	1.030×10^{12}
Aluminum Oxide (Al_2O_3)	+	3.835×10^{12}
Aluminum Oxide (Al_2O_3)	+	4.895×10^{12}
Aluminum Nitride (AlN)	+	4.367×10^{12}
Beryllium Oxide (BeO)	+	4.367×10^{12}
Borophosphosilicate (BPSG) glass	+	1.500×10^{11}
Gallium Arsenide (GaAs)	111	1.741×10^{12}
Gallium Arsenide (GaAs)	100	1.239×10^{12}
Germanium (Ge)	111	1.837×10^{12}
Germanium (Ge)	100	1.420×10^{12}
Phosphosilicate (PSG) glass	+	9.88×10^{11}
Silicon	111	2.290×10^{12}
Silicon	100	1.805×10^{12}
Sodalime glass (Corning microsheet 0211)	+	9.73×10^{11}

* polycrystalline
\+ amorphous

13.3.4 TAKING A POSTSTRESS SCAN

To take a poststress scan and display the difference trace and data:

1. With the Stress screen displayed, press START to scan the sample.
2. If the Database Manager Option is not installed, the Alphanumeric window is displayed (Fig. 3-13). Enter the Wafer ID of the sample, for example, MXB23, and press ENTER. The instrument scans the sample, computes the difference measurement, and displays the Stress screen with the difference trace displayed.

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If the Database Manager Option is installed, the following window is displayed:

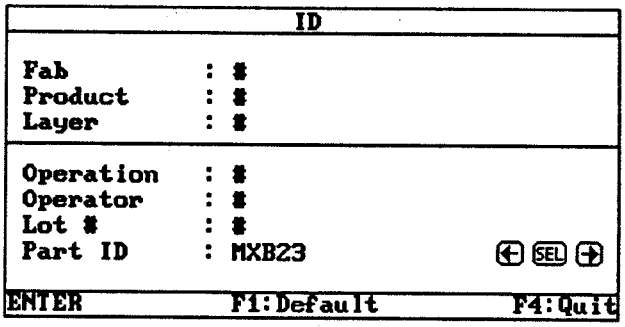


Figure 13-6 ID Window

Use [←] or [→] to select the same values used to save the prestress data. Press ENTER to continue with the scan.

The Scan screen (Fig. 6-30) is displayed during the scan. After the scan is completed, the Stress screen is displayed:

- In the window, the Wafer ID is now MXB23-D. The suffix -D shows that the program found the prestress data and has computed the difference measurement. The displayed trace is the difference trace.
- The plot label also displays: *Difference Trace, Post Stress - Pre Stress*. The plot shows the difference between the profile before and after the stress inducing process.
- The computed values of stress are shown at the left in the Avg, Max, and Cent fields.

NOTE: **In the absence of any prestress data for wafer MXB23, the ID will show MXB23-P to signify that the trace is not the difference measurement but the poststress trace.**

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13.3.5 SAVING POSTSTRESS DATA

The difference trace cannot be saved but can be recalculated and displayed if both the pre- and poststress raw data and summary are saved (see Section 13.3.6, "Displaying Difference Measurements," for procedures).

> **NOTE:** **Save both the poststress raw data and summary if you wish to compute difference traces later.**

To save the poststress data:

1. From the Stress screen, press [F4: Save] to save the data:

- If the Database Manager Option is not installed, the Alphanumeric window is displayed. Enter the prestress Wafer ID with the suffix -P and press ENTER to save the data. The program displays the following message:

  Save Raw Data + Summary [Y] or Summary Only [N]?

  Press Y to save both the raw data (trace) and the Summary screen.

- If the Database Manager Option is installed, the Database Save IDs window (Fig. 12-14) is displayed:

  Note: The database should be configured before you start saving data. See Section 12.2, "Configuring the Database," for more information.

  - Save the poststress data using the identical values used to save the prestress data. See Section 13.2.3, "Profiling the Sample," for details.
  - Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs.
  - Enter MXB23, the ID for this example, for the seventh ID (Part ID in Fig. 12-14).
  - Use [←] or [→] to select both the Summary and Raw Data.
  - When done entering values for the IDs, press ENTER to save the data.

  The Stress screen remains on the screen until you begin another operation.

13.3.6 DISPLAYING DIFFERENCE MEASUREMENTS

Use the following steps to display a difference measurement if both the pre- and poststress raw data and summary were previously saved.

To display a difference measurement:

1. From the menu bar, choose Stress from the Analysis menu and press ENTER to display the Stress screen.
2. Press [F2: Data Catalog] to display the Data catalog:

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If the Database Manager Option is not installed, the Data catalog is displayed (Fig. 7-21).

If the Database Manager Option is installed, the following window is displayed:

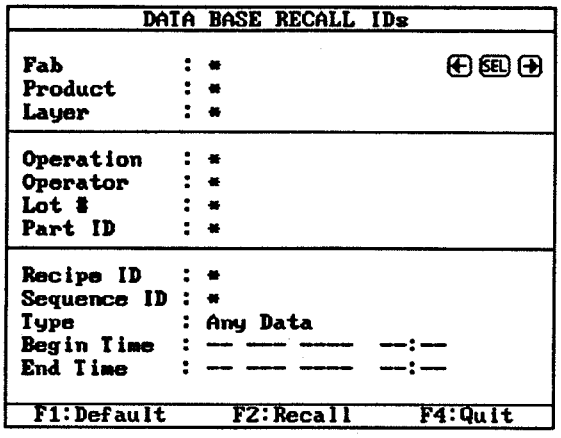


Figure 13-7 Database Recall IDs Window

See Section 12.3.3, "Recalling Data" for more information on recalling data.

- Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs. You also can type in the ID values if known.
- To display the entire database, enter the wildcard (*) in all the IDs. To enter the wildcard, use [↑] or [↓] to select each ID and press CLEAR on the built-in keyboard or DELETE on the remote keyboard.
- Use [←] or [→] to select both the Summary and Raw Data.
- When done entering values for the IDs, press ENTER to display the Database catalog (Fig. 12-19).

3. Press [↑] or [↓] to select the post-stress measurement. Remember, the IDs of prestress measurements have no suffix and the IDs of post-stress measurements have a -P suffix. Press ENTER to select the poststress scan.
4. The program displays the following message:

   Save Current Recipe? [Y/N]

   Enter N. The program displays the Stress screen with the difference measurement computed. Notice that the Wafer ID has the suffix -D, indicating that the trace is a difference measurement. If the Wafer ID displays the suffix -P, the program could not find the prestress trace to compute the difference measurement, and the displayed trace is the poststress measurement.

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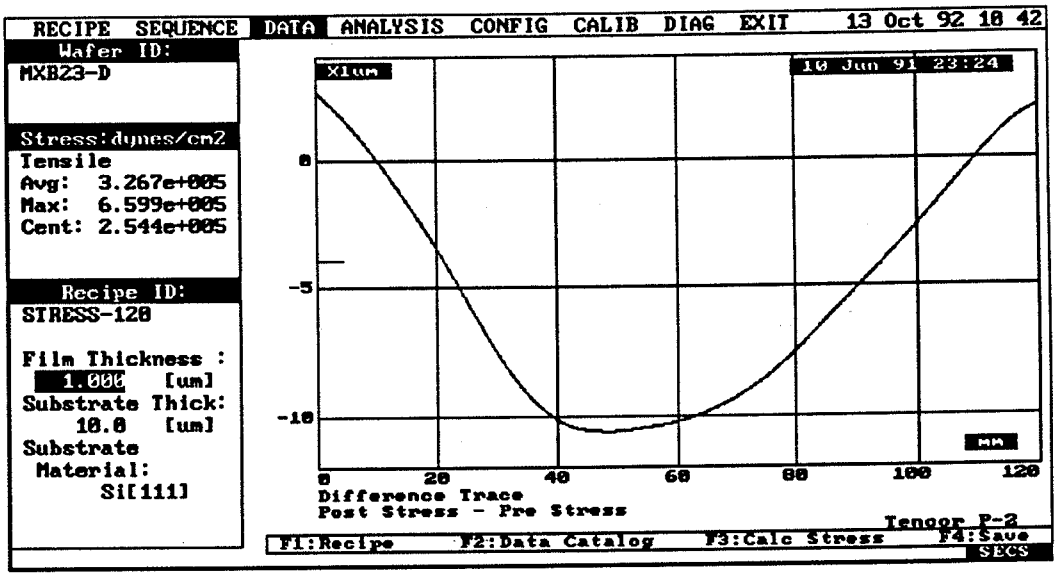


Figure 13-8 Difference Trace and Data

Note: If the item selected does not have a -P suffix, the program will display the error message "For Stress Calculations, Wafer ID must have -P or -D appended." If you are sure that the selected item is a poststress trace, change the ID of the item using the following steps:

1. Exit the error window by pressing any key. Then press ID on the built-in keyboard or F12 on the remote keyboard.
2. Type the Wafer ID but with the suffix -P and press ENTER.

13.3.7 TAKING MULTIPLE MEASUREMENTS OF THE SAME SAMPLE

You can measure stress on a sample any number of times, and you can compare the current trace with the trace from any previous measurement.

To take multiple measurements:

1. Save the first poststress measurement with a suffix of -P1 instead of -P. For example, save Sample MBX23 as MBX23-P1.
2. After processing the sample, load the sample and display the Stress screen.
3. Enter the ID with the -P1 suffix so that the ID now reads MBX23-P1. The data is now considered to be the prestress data for this measurement. After the sample is scanned, the new data is given the ID MBX23-P1-P to indicate that it is a new poststress measurement. You can save the data with this suffix or use -P.

   Each time you process the sample, you can compare current stress with any earlier measurement, including the first, prestress scan where the ID has no suffix.

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13.4 TAKING A SINGLE, POSTSTRESS MEASUREMENT

A single, poststress measurement measures the current curvature of the sample. In its calculations, the program assumes that the sample was flat before being stressed.

To take a single, poststress measurement:

1. Load the sample.
2. Choose a recipe.
3. Position the sample for the scan.
4. Display the Stress screen.
5. Enter film and substrate information for the sample.
6. Press START.
7. Enter a new ID that is different from any other ID already in the Data catalog.
8. After the scan is complete, the results are displayed in the Stress screen. The Wafer ID contains the suffix -P to indicate that this is a poststress measurement and trace.

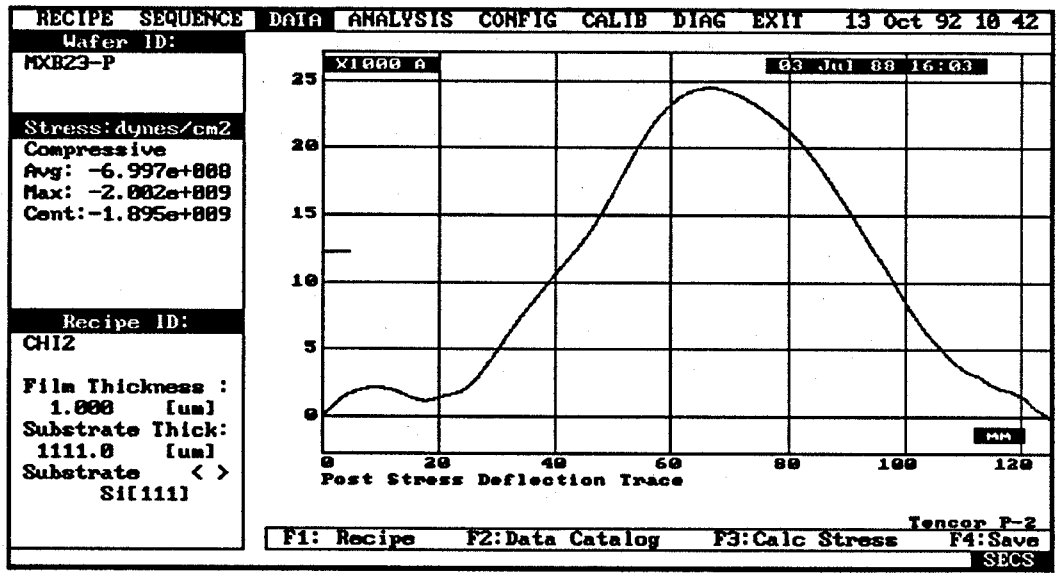


Figure 13-9 Stress Screen: Poststress-Only Measurement

9. Press [F4: Save] to save the poststress measurement. See Section 13.3.5, "Saving Poststress Data," for details on saving poststress data.

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13.5 RECALCULATING STRESS MEASUREMENTS

You can recalculate stress measurements provided you saved the raw data and summaries for both pre- and poststress measurements. For example, you can do this to correct a mistake in the film thickness that was entered when you took a measurement.

To recalculate a measurement:

1. Choose Stress from the Analysis menu and press ENTER to display the Stress screen.
2. Press [F2: Data Catalog] to display the Data catalog.

   If the Database Manager Option is not installed, the Data catalog is displayed (Fig. 7-21).

   If the Database Manager Option is installed, the Database Recall IDs window is displayed (Fig. 12-6).

   See Section 12.3.3, "Recalling Data," for more information on recalling data.

   - Use [↑] or [↓] to move between the IDs. Use [←] or [→] to select assigned values for the IDs.
   - To display the entire database, enter the wildcard (*) in all the IDs. To enter the wildcard, use [↑] or [↓] to select each ID and press CLEAR on the built-in keyboard or DELETE on the remote keyboard.
   - Use [←] or [→] to select both the Summary and Raw Data.
   - When done entering values for the IDs, press ENTER to display the Database catalog (Fig. 12-19).
3. Press [↑] or [↓] to select the ID for the stress measurement. Remember, the IDs of prestress measurements have no suffix and the IDs of poststress measurements have a -P suffix. Press ENTER to select it.
4. The program displays the following message:

   Save Current Recipe? [Y/N]

   Enter N. The program displays the Stress screen with the data from the scan. Notice that the Wafer ID is the one that you selected but with the suffix -D, indicating that the difference has been computed.
5. Make the necessary changes. For example, enter a new film thickness.
6. Press [F3: Recalc Stress] to redo the stress measurement. The program displays the results in the window.
7. Press [F4: Save] to save the new summary data. (See Section 13.3.5, "Saving Post-Stress Data," for details). Note: You will lose the previous summary data unless the new summary data is saved under a new ID.

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14 INTERACTIVE 3-D OPTION

The Interactive 3-D Option enables you to take a series of scans a fixed distance from each other and display the traces in a 3-D Data screen. This option also enables you to

- Display a 3-D perspective (color-coded for height) including a selected single trace and the precise measurements corresponding to the position of its cursors in a single screen
- Select the angle or direction from which you view the surface
- Choose either a contour display or top view
- Select and analyze any one of the traces
- Instantly rescan a selected area
- Zoom data in the 3-D Data screen up to ten levels
- Level 3-D data
- Display and print 3-D data in color or monochrome

NOTE: Due to the longer scan time required for 3-D plots, the scan resolution will be less than the 2-D scan resolution. See Section 14.2, "Profiling From a 3-D Recipe," for details.

14.1 WRITING A 3-D RECIPE

To take data with the 3-D option, you will need to write a 3-D recipe (see Fig. 14-2). This recipe is similar to the standard 2-D Scan recipe and can be included in a Sequence in the same manner.

To write a 3-D recipe by changing the current Scan recipe:

1. Choose View/Modify from the Recipe menu and press ENTER.
2. Press [↑] or [↓] to get to the Recipe Type Field, then press [←] or [→] to select 3-D.
3. Toggle through the line items by pressing [↑] or [↓] or by using the trackball and change values as needed.

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4. Press [F1: Save] to save the new recipe. The following window is displayed:

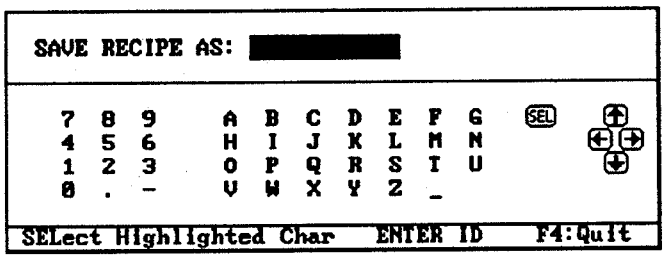


Figure 14-1 Save Recipe Window

5. Enter a new ID in the window and press ENTER. (Refer to Section 3.5, "Entering an ID," for details.) The recipe is saved in the Recipe catalog. The new ID entered is displayed on the first line of the Recipe screen. The type field in the Recipe catalog will display 3-D.

You also can write a 3-D recipe by selecting a recipe from the recipe catalog and modifying it as described above.

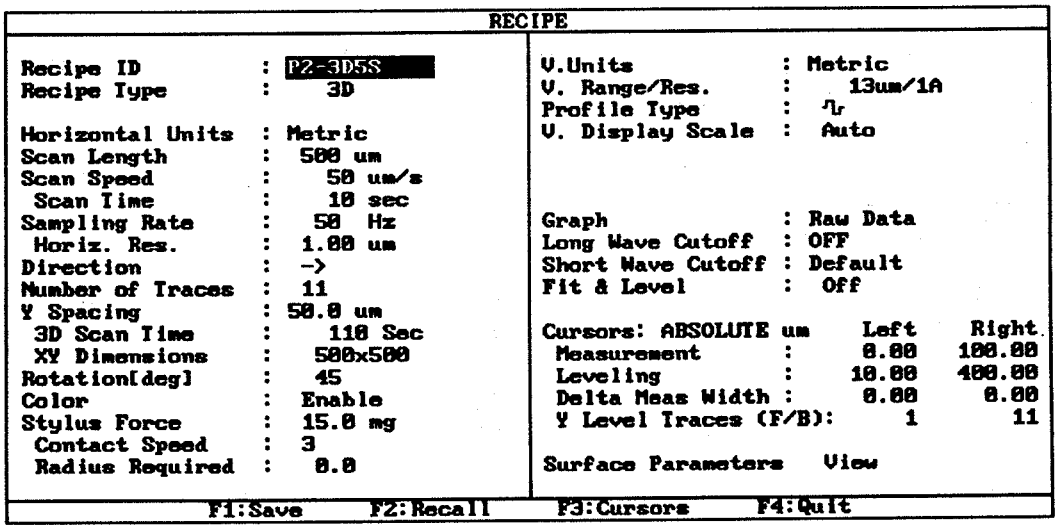


Figure 14-2 3-D Recipe

Scan parameters specific to a 3-D recipe are as follows:

Number of Traces

Enter the number of scans to be taken (2 – 210).

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NOTE: **The 3-D scan can cover a maximum area of 140 mm x 140 mm. The maximum number of scans is 210 with the total scan time not exceeding 3,000 s. For example, you can take a maximum of 150 scans of 20 s each.**
If you take more than 45 scans, the display will be an equal subsampling of all the scans taken. To view all the scans, use the zoom option explained later in this chapter.

Y Spacing

Using the keypad, enter the distance between the scans in the Y direction, or press [←] or [→] to toggle between preselected values.

3D Scan Time

3D Scan Time is a computed parameter that depends on the number of traces and the Y Spacing value. This value is not entered by the user. Time refers to only the period during which the instrument is taking scans.

XY Dimensions

These are computed parameters that depend on the number of traces and the Y Spacing value. These values are not entered by the user. *Time* refers to only the period during which the instrument is taking scans. *XY Dimensions* are the dimensions of the 3-D scan on the sample. Use approximately equal X and Y dimensions to preserve the appearance of natural proportions.

NOTE: **For high resolution measurement, minimize the impact of thermal drift by adjusting all relevant parameters (such as scan speed, scan length, and Y spacing) for the shortest scan time consistent with the measurement.**

Rotation

Press [←] or [→] to select the angle of view in degrees. The rotation of the view is done counterclockwise. The available values are: Top, 0, 45, 135, 225, and 315 degrees. Top displays a contour representation, or top view, of the surface.

Color

With the 3-D Option you can plot the data in either monochrome or in color. Each color in the plot corresponds to a data range indicated by the same color on the height bar. If you disable the color selection, the data will be plotted in a single color—yellow. (You cannot change this color.)

If you enable the color selection, the instrument automatically sets the color for each data range. The instrument also sets the intervals to which the colors apply, and you cannot change these settings. Press [←] or [→] to enable or disable color.

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- If you are using a monochrome printer and enable color, all colors will print as black, that is, there is no grey-scaling capability. However, it is advisable to disable color if printing on a monochrome printer as some colors might not map to black.
- If you are using a color printer, the screen colors will be mapped to the printer colors, but there is no guarantee that the screen colors will match the printer colors exactly.

Cursors: Y Level Traces (F/B)

You can change the leveling of the set of scans along the Y direction by selecting which of the individual traces should be the front and which should be the back. Front and back refer to the order the traces are taken relative to the front and back of the instrument's measurement area. The individual traces of 3-D scans always go from front to back.

The default is trace number 1 in the left column, and trace number *n* in the right column, where *n* = Number of Traces. Allowed values for the left value depend on the number of traces, but can be any whole number in the range 1—*n-1*. Allowed values for the right value depend on the left value and the number of traces, but can be any whole number in the range *left value* + *1*—*n*. For example, using the Number of Traces from Fig. 14-2, if we wanted to set the front trace for Y leveling to be number 3, then the back trace could be 4, 5, 6, 7, 8, 9, 10, or 11.

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14.2 PROFILING FROM A 3-D RECIPE

Start a scan with a 3-D recipe as you would with a standard Scan recipe.

To scan from a 3-D recipe:

1. Choose View/Modify from the Recipe menu and press ENTER to display the current 3-D recipe or Scan recipe. If the desired 3-D recipe is not the current recipe, select the correct recipe from the Recipe catalog.
2. Load the sample and position the stylus on the sample surface. Set the stylus at the lower left hand corner of the area to be scanned. Use the X,Y readouts in the Motion screen (Fig. 6-7) for measurements if an artifact is to be framed.

NOTE: Due to the long scan time required for a 3-D plot, 3-D data is more sensitive to thermal drift. This thermal drift will manifest itself as an arc or bow (as high as 0.5 μm for very long scans) in the Y direction. You can reduce the bow to a few hundred angstroms (0.1 μm maximum). Select a 3-D recipe with the shortest scan time consistent with the measurement. After loading the sample, position the stylus on the sample surface to bring the elevator to its final position, and close the measurement door. Allow a minimum of 15 min. for thermal equilibrium before pressing START.

A scan count number is displayed to help monitor the scanning progress. When complete, the 3-D Data screen is displayed:

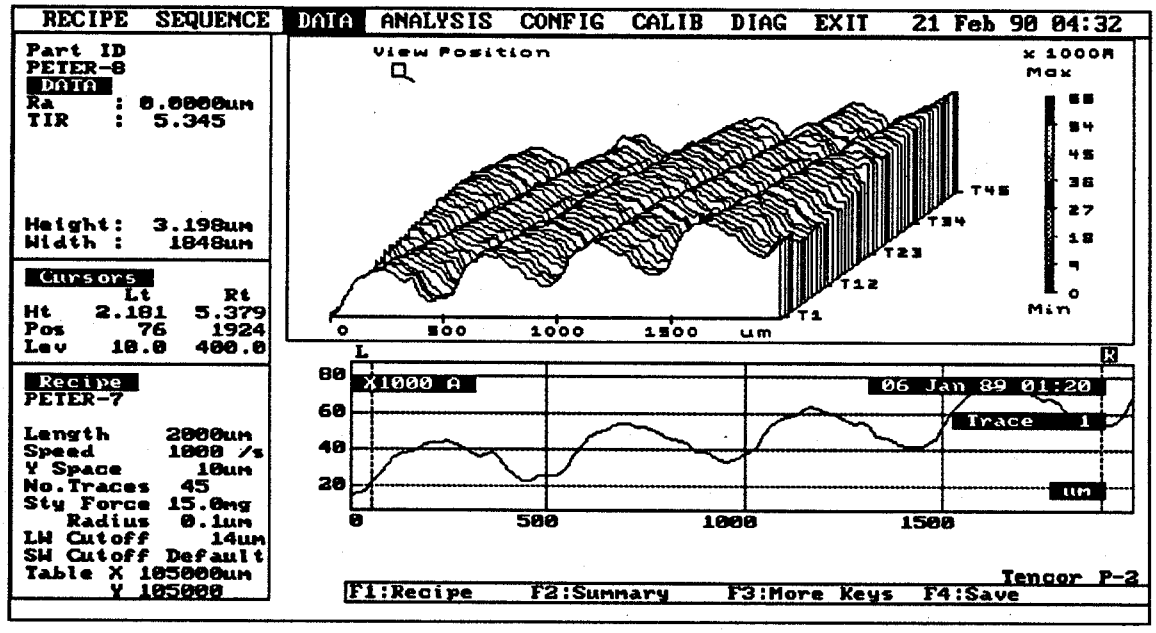


Figure 14-3 3-D Data Screen

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14.2.1 READING THE 3-D DATA SCREEN

3-D BOX

The 3-D box displays the 3-D plot of the surface and an icon under the label "View Position" indicating the current direction (angle) of view. The X-axis label displays length and the Y-axis label shows the trace number, for example, T23 means the 23rd trace in the 3-D scan. Data is plotted in different colors with each color corresponding to a range of height values.

The height bar is a color-coded bar showing the height intervals in which data occurs. Each color corresponds to a range of values.

SINGLE TRACE BOX

The Single Trace box appears below the 3-D box and is similar to the standard Graph box in the 2-D display. The only exception is that you cannot level or zoom data in the Single Trace box. You can level or zoom data in the 3-D box only. Note: When you level data in the 3-D box, the trace in the Single Trace box also will be leveled.

The trace that appears initially in the Single Trace box is the first trace generated during a previous 3-D scan. You can select any trace to display in the Single Trace box. See Section 14.3.1, "Selecting a Single Trace."

DATA BOX

The Data box of the 3-D Data screen is similar to that of the standard 2-D display except for the addition of the following values:

Y Space Y distance between the scans.

No. Traces Total number of scans.

The Table XY values identify the coordinates of the start of scan of the first trace.

NOTE:	**The data in the Data box refers to the Single Trace box and not to the 3-D box.**

FUNCTION KEYS IN THE 3-D DATA SCREEN

- Press [F1: Recipe] to display the current 3-D recipe.
- Press [F2: Summary] to display the corresponding data summary.
- Press [F4: Save] to save the current data.
- Press [F3: More Keys] to gain access to additional function keys (Fig. 14-4).

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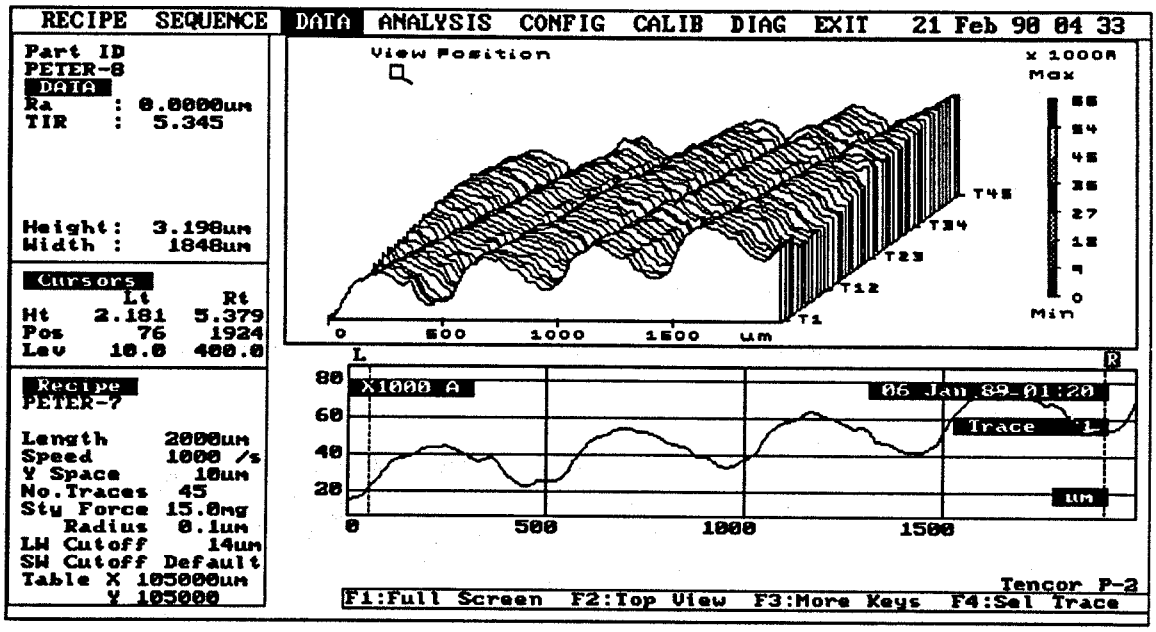


Figure 14-4 Additional 3-D Data Screen Keys

In the Additional Keys window:

- Press [F1: Full Screen] to expand the 3-D box to the whole screen. The Summary box and the Single Trace box will not be visible.
- Press [F2: Top View] to view the 3-D scan from the top.
- Press [F4: Sel Trace] to select any trace. See Section 14.3.1, "Selecting a Single Trace," for more information.
- Press [F3: More Keys] to return to the previous display of prompts.

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14.3 ANALYZING THE 3-D DATA

14.3.1 SELECTING A SINGLE TRACE

You can select single traces to take precise measurements using the left and right cursors. The measurements will be displayed in the Data box.

To select a trace to be displayed in the Single Trace box:

1. In the 3-D Data screen (Fig. 14-5), press [F4: Sel Trace].

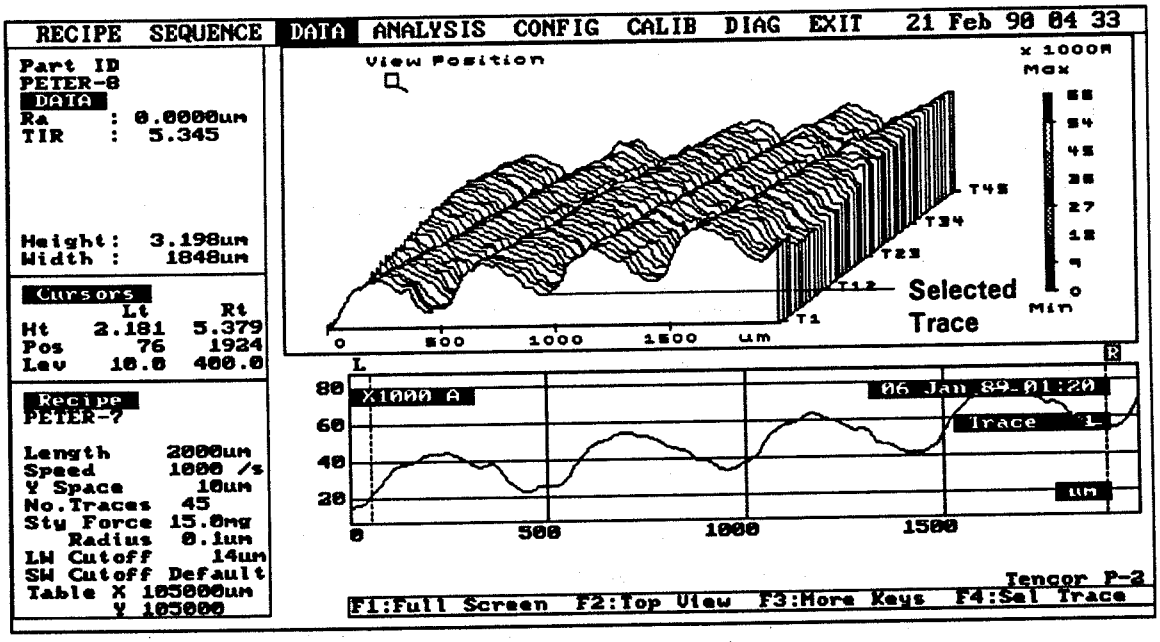


Figure 14-5 Selecting a Trace

2. The first scan, that is, the one closest to the front, will be highlighted in white so that you can distinguish the selected trace from the others. Use the trackball or press [↑] or [↓] to select another trace.

3. To copy the trace to the Single Trace box, press SEL.

Note: The selected single trace does not get copied to the Single Trace box automatically. You must press SEL each time after selecting a trace if you want the trace to be displayed in the Single Trace box. The cursors can be used in the same manner as in a normal 2-D trace display.

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14.3.2 VIEWING A CONTOUR DISPLAY

From the 3-D Data screen, you can generate a contour display or top view. Areas with the same height are shown in the same color.

To view a contour display:

1. From the 3-D Data screen, press [F3: More Keys]. Then press [F2: Top View] to display the contour display (Fig. 14-6).

   Note: The following screen also can be viewed simultaneously with a perspective view by pressing ZOOM. See Section 14.5, "Zooming Data in the 3-D Data Screen," for details.

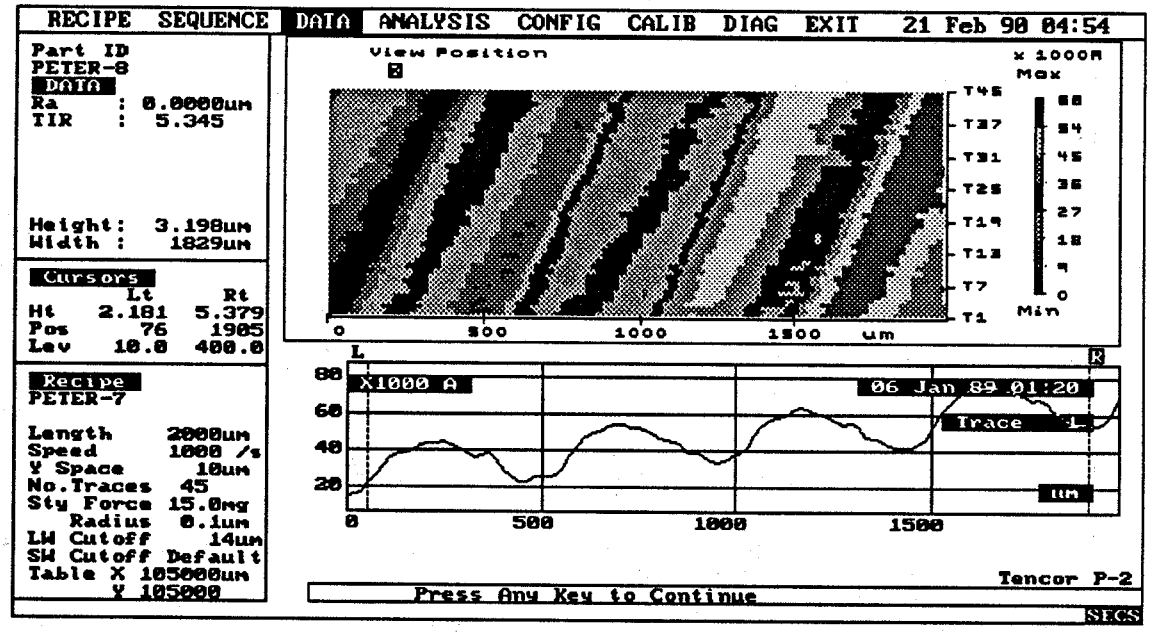


Figure 14-6 Contour Display

2. To return to the 3-D display, press any key.

You can print the contour display on a color printer only.

14.3.3 CHANGING THE VIEW POSITION

To change the view from which the surface is seen, modify the Rotation field in the 3-D recipe as described below. The view is rotated counterclockwise. Available values include Top, 0, 45, 135, 225, and 315 degrees.

To change the view:

1. In the 3-D Data screen (Fig. 14-3), press [F1: Recipe].
2. In the Rotation field press [←] or [→] to select the angle of view in degrees.
3. Press [F1: Save] if you want to save the new recipe, or

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Press [F4: Quit].

14.4 LEVELING 3-D DATA

Use the 3-D leveling feature to level all or selected parts of a 3-D display. Leveling is done based on the three corners of the leveling box (Fig. 14-7). The lower two corners define the leveling points in the X direction and the upper and lower left corners define the leveling points in the Y direction.

> **NOTE:** The Fit and Level setting (see Section 7.7, "Fit and Level") does not work for 3-D scans.

To level a 3-D display:

Note: You cannot level individual traces of a 3-D scan.

1. In the Data screen (Fig. 14-3), press LEVEL on the built-in keyboard or [F10: Level] on the remote keyboard to open the Leveling window with the perspective plot and contour plot side by side.

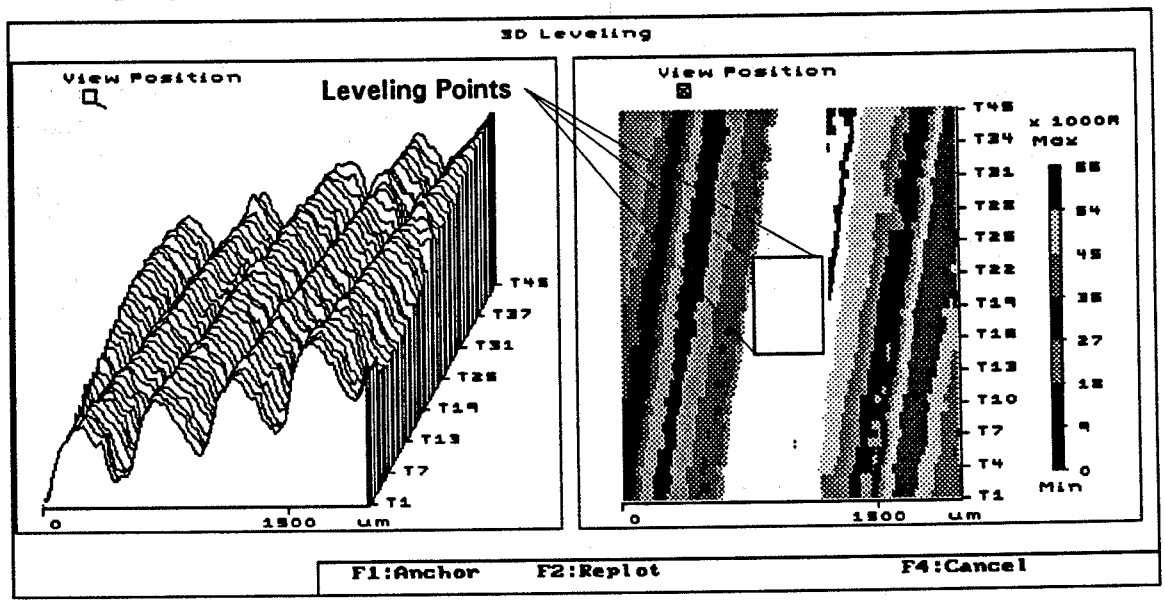


Figure 14-7 Leveling a Set of 3-D Data

2. The rectangular box in the Contour Plot window (Fig. 14-7) is the leveling box. Move the box with [←], [→], [↑], [↓], or the trackball.
   - Press [F1: Anchor] to anchor the lower left corner of the box. Change the size of the box with [←], [→], [↑], [↓], or the trackball.
   - Press [F1: Anchor] again to anchor the leveling box, and then press [F2: Replot].

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3. All the scans will be leveled and replotted in both the 3-D box and the Single Trace box of the Data screen.

14.5 ZOOMING DATA IN THE 3-D DATA SCREEN

Use the zoom feature to magnify a particular section of the 3-D display. This feature also can be used to display all the programmed traces in a scan that has more than 45 traces. You can zoom up to ten levels in one 3-D Data screen.

To zoom data:

Note: You cannot zoom individual traces of a 3-D scan.

1. In the Data screen (Fig. 14-3), press ZOOM to open the Zoom window containing the 3-D plot and contour plot side by side:

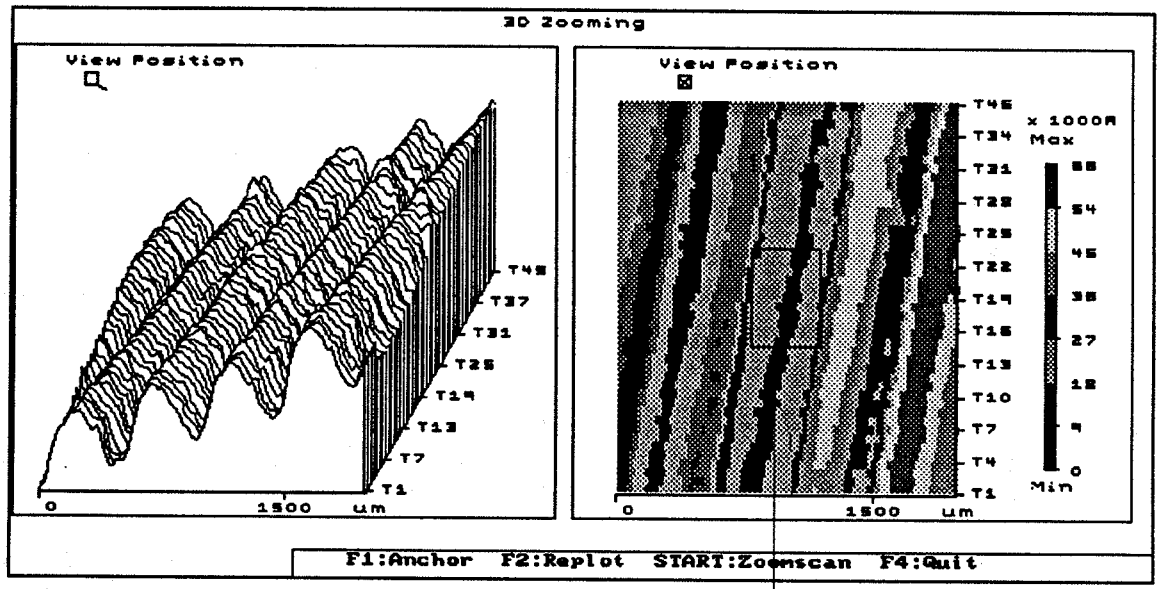


Figure 14-8 Zoom Option Screen

Zoom Box

2. The rectangular box in the Contour Plot window is the zoom box. Move the box with [←], [→], [↑], [↓], or the trackball.

   - Press [F1: Anchor] to anchor the lower left corner of the box and change the size of the box with [←], [→], [↑], [↓], or the trackball.
   - Press [F1: Anchor] again to anchor the zoom box, and then press [F2: Replot]. The following message will be displayed:

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```
Current data will be lost if not saved.
To save, press [F4: Quit], then [F4: Save].
To scan zoom box, press START.
```

- If you want to save the current 3-D scan and have not done so, press [F4: Quit] to exit to the Data screen. Then press [F4: Save] to save the 3-D data. After saving the 3-D data, press ZOOM to return to the zoom feature.
- If you have already saved the current 3-D data or do not wish to save the data, press START to begin the zooming.
- To return to the Surface Plot and Contour Plot windows without doing either of the above, press any key on the keyboard.

3. The Data screen is displayed with the selected scans zoomed. Note that the proportions of the view will be altered if the zoom box proportions are not kept the same as the total view.
4. To zoom again, repeat steps 1 and 2. You can zoom data up to ten times in a single 3-D Data screen.
5. To return to the previous Data screen, press UNDO on the built-in keyboard or backspace on the remote keyboard and then ZOOM. In a multiple zoom, you will need to repeat this step to return to each previous level of zoom.

14.5.1 RESCANNING A SELECTED AREA

This feature allows you to rescan a selected area in a 3-D scan for improved horizontal resolution over a limited X-Y area defined by the zoom box.

Note: When rescanning a selected area using the zoom box, the recipe will be modified to keep the scan time constant; the Y resolution will have a 1-μm minimum; and the scan speed will decrease in discrete amounts and have a minimum value of 1 μm/s for sampling rates below 200 Hz, or 2μm/s for sampling rates above 200 Hz. Also note that to rescan a selected area using the zoom box, the total scan time must be less than 3000 s.

To rescan a selected area:

1. In the Data screen (Fig. 14-3), press ZOOM to open the Zoom window containing the surface plot and contour plot side by side (Fig. 14-8).
2. Move the zoom box (Fig. 14-8) with [←], [→], [↑], [↓], or the trackball.
   - Press [F1: Anchor] to anchor the lower left corner of the box and change the size of the box with [←], [→], [↑], [↓], or the trackball.
   - Press [F1: Anchor] again to anchor the zoom box, and then press START. The following message is displayed:

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Current data will be lost if not saved.
To save, press [F4: Quit], then [F4: Save].
To scan zoom box, press START.

- If you want to save the current 3-D scan and have not done so, press [F4: Quit] to exit to the Data screen. Then press [F4: Save] to save the 3-D data. After saving the 3-D data, press ZOOM to return to the zoom feature.
- If you have already saved the current 3-D data or do not wish to save the data, press START to initiate a new 3-D plot. This new 3-D plot will have increased horizontal resolution. Note: The recipe used is the same one as used in the original 3-D scan.
- To return to the Surface Plot and Contour Plot windows without doing either of the above, press any key on the keyboard.

3. The Data screen will be displayed with the new scan data.
4. To zoom rescan again, repeat steps 1 and 2. You can zoom rescan data up to ten times in a single 3-D Data screen.
5. To return to the previous Data screen, press UNDO on the built-in keyboard or backspace on the remote keyboard and then ZOOM. In a multiple zoom rescan, you will need to repeat this step to return to each previous level of zoom.

14.6 SAVING 3-D DATA AND RECIPES

3-D recipes and data from 3-D scans are saved in the same way as 2-D recipes and data. See Section 7.9, "Saving Data and Recipes," for details.

CAUTION: Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk," for details.

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15 OFFLINE P-2 PROGRAM

The Offline P-2 Program can be loaded into your personal computer for analysis and manipulation of data. The ability to analyze data from multiple Tencor P-2 units on an offline PC saves both time and expense. Instead of performing all the detailed analysis on the production floor, you can conveniently transfer data to an office environment. You can then dedicate the instrument to measurement tasks, while data analysis is performed offline at the same time.

This option includes all available Tencor P-2 software packages. Measurement data can be viewed offline and manipulated using the standard and the band pass filters. You can do stress calculations and display three-dimensional data. You also can selectively retrieve data using the Database Manager and download or upload to another host using the SECS interface.

This chapter covers

- System requirements
- Software installation
- Offline program operation
- Offline program directories

15.1 SHIPPING CONTENTS

Each copy of the offline software is shipped with the following items:

- One Tencor P-2 user manual
- One set of release notes (Note: Release notes published at the same time as the user manual are included as an appendix in the manual.)
- One Offline P-2 Program 3.5-in. diskette
- One Database Tutorial 3.5-in. diskette
- One computer keyboard with Tencor P-2 overlay

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15.2 SETTING UP THE OFFLINE SOFTWARE

15.2.1 SYSTEM REQUIREMENTS

You will need the following minimum computer hardware to run the offline software:

- PC/AT compatible computer with 80286, 80386 or 80486 controller
- EGA or VGA graphics card and monitor
- 20 MB or larger hard disk with 640K of RAM and 512K of expanded memory. The expanded memory should be set up in the CONFIG.SYS file in the root directory (C:\).
- DOS version 5.0 or higher

NOTE:	**If your personal computer does not have a CONFIG.SYS file or if the CONFIG.SYS file is not set up in the root directory (C:\), you will not be able to install the offline program.**

You also will need the following additional hardware to support interactive 3-D displays:

- 386 or better system is recommended
- Math coprocessor
- Minimum of 1-MB RAM (total of 2 MB); 3 MB (total of 4 MB) is recommended

NOTE:	**The offline software works only with data, recipes, and sequences generated with Tencor P-2 software versions 1.3, 1.3.1, 1.3.2, and 1.4, 1.4.2, 1.5, 1.5.1, and 1.6.**

15.2.2 SYSTEM CONFIGURATION

Before installing the software, the system must be configured to access the expanded memory. This should be set up in the CONFIG.SYS file in the root directory (C:\).

You can use the following memory managers and memory systems:

386 memory managers:

- 386MAX from Qualitas, Inc.
- QEMM-386 from Quarterdeck Office Systems

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It will be necessary for you to load a memory device driver and create a virtual disk before running the offline software. Add these device drivers to your CONFIG.SYS file if it does not already load these drivers when booting. The CONFIG.SYS file should be located in the root directory (C:\) of your personal computer. Use the DOS line editor, EDLIN, or a word processing program to edit the CONFIG.SYS file.

To set up the CONFIG.SYS file:

1. Load the memory device driver in the CONFIG.SYS file according to the manufacturer's specifications. Note: With extended memory managers, be sure to assign space for expanded memory.
2. To create the virtual disk, a line such as the following should appear in the CONFIG.SYS file (refer to your DOS manual for specific configuration requirements):

   DEVICE=C:\DOS\VDISK.SYS 1024 128 50 /E:2

   Note: DOS VDISK might have problems with extended memory managers. Use the RAM Disk program supplied with the extended memory manager if you have this problem.
3. Save the CONFIG.SYS file and exit the editor.
4. Press RESET to reset your computer. This will register the configuration changes.

Some programs, such as Microsoft Windows, could require special memory device drivers that are incompatible with the offline software. In such cases, you will need two different configuration files that must be renamed CONFIG.SYS before rebooting the system and running the offline software.

Network programs also can cause memory conflicts because they require considerable memory to run. In such cases, it might be necessary not to access the network while running the offline software or to increase the amount of memory in your system to accommodate both the network and the offline software.

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15.2.3 SOFTWARE INSTALLATION

After successful system configuration, install the offline software using the following procedure:

1. Plug the printer cable into the first printer port (LPT1) of your computer.
2. At the DOS prompt, change the drive to the drive from which you intend to install the offline software.
3. Insert the first Offline P-2 Program diskette into the drive. Type *install* and press ENTER.
4. The installation program prompts you to enter the name and path of the directories for the program, system, and utility files.

> **NOTE:** **Although you can install files in directories other than the default directories, the offline software will only run with the system file in the SYS directory located directly under the root directory (C:\SYS). The program and utility files can be located in directories other than the default directories (TENCOR and UTIL). However, if you use directories other than the default, you must update the path statement in the AUTOEXEC.BAT file to include the directory names of the program and utility files.**

15.3 RUNNING THE OFFLINE P-2 PROGRAM

To run the Offline P-2 Program:

1. At the DOS prompt type *cd\tencor* if you used the default directory when installing your software or change to the directory where the program files are located and then press ENTER.
2. Type *p2* and press ENTER.
3. The software is loaded and you are prompted to press ENTER to initialize the software. If the software displays any error messages during operation, refer to Chapter 16, "Error Messages."

> **NOTE:** **Do not reset the computer before exiting from the offline software to DOS. This could cause database corruption.**

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15.4 OFFLINE P-2 PROGRAM DIRECTORIES

This section describes the directories and subdirectories of the Offline P-2 Program. Use the information provided in this section to verify that all the required files are present on your personal computer's hard disk.

The required directory structure of the Offline P-2 Program is displayed in Fig. 15-1.

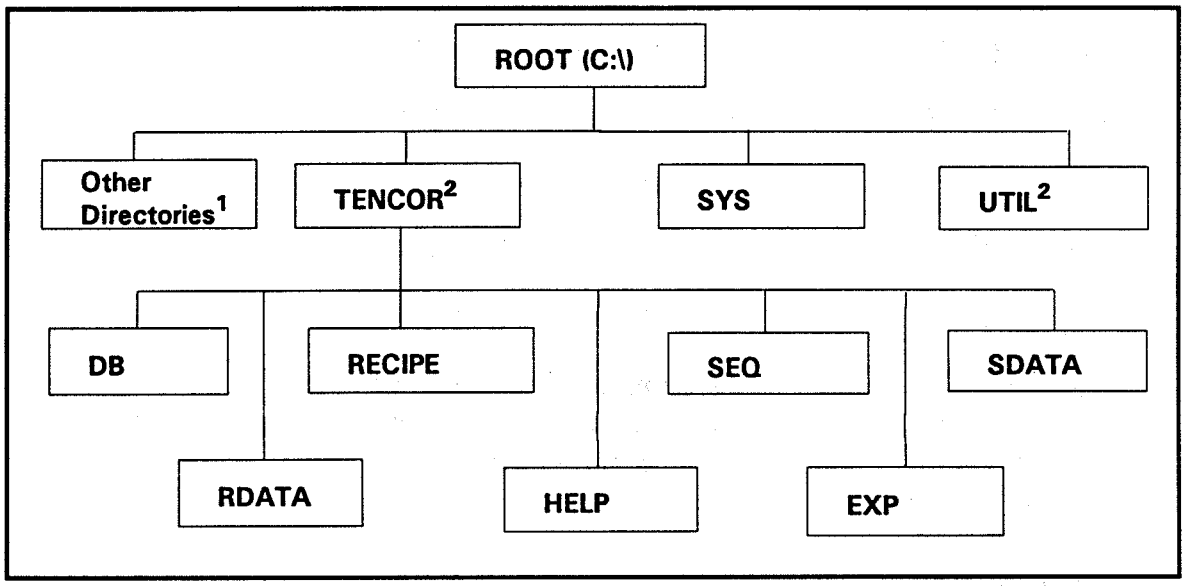


Figure 15-1 Tencor Off-Line Program Directory Structure

The contents of all offline software directories except the program directory (default TENCOR) are identical with those of the instrument program. See Section 18.7, "Tencor P-2 Directories," for lists of the directory files and their descriptions.

[1]Other Directories indicates directories that were present on your personal computer's hard disk prior to installing the Offline P-2 Program.
[2]Default directory.

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Program Directory

The program directory (default TENCOR) contains programs and data files necessary to run the offline software. It also contains support programs and subdirectories that support main program functions. The following files must reside in the program directory:

Filename	Description
CALIB.SYS	Calibration/system setup file
P1_HELP.SYS	Main help system file (ASCII)
P1DBASE.DBD	Database definition file
P2PC.EXE	Main Offline P-2 Program
P2.BAT	Batch file to start the main program
P1DB0.SYS P1DB1.SYS P1DB2.SYS P1DB3.SYS P1DB4.SYS P1DB5.SYS P1DB6.SYS P1DB7.SYS P1DB8.SYS	Prototype database files used by the main program to initialize the database when no files are present

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16 ERROR MESSAGES

16.1 FILE SYSTEM OR HARD DISK PROBLEMS

Many of the following error messages arise from problems associated with memory limitations or hard disk corruption.

16.1.1 DISK SPACE LIMITATIONS

The DOS DIR command provides a listing of files, file sizes, and information on the total amount of space used on the entire disk. Use this command to determine disk space availability.

If your hard disk is full and you have used only the instrument software (that is, no third party applications), you probably have saved too many raw traces or exported data files. To delete exported data files, you must erase them in the DOS environment (see Section 18.2.3, "Erasing a File"). You can delete raw data from the Data catalog (see Section 7.11.1, "Deleting Data without the Database Manager Option," if you do not have the Database Manager Option, and Section 7.11.2, "Deleting Data with the Database Manager Option," or Section 12.3.5, "Deleting Data," if you have the Database Manager Option) unless there is insufficient memory to display the catalog. In this case, call Tencor Service. See Section 17.1.1, "Service Policy," for more information.

16.1.2 HARD DISK CORRUPTION

Hard disk corruption is one of the most serious problems that can occur and is the major purpose for periodic backups of critical files on the hard disk. The DOS CHKDSK utility provides an initial check of file system integrity and will catch most problems. Other commercially available utilities perform much more extensive tests on disks to help isolate as well as prevent problems caused by defective media.

If you encounter serious corruption of Tencor P-2 system or data files, restore them from the last backup (see Section 18.2.6, "Database Recovery," for procedures). If the error messages involve only a few specific items, try deleting those items only and then save all the other items that have not been backed up.

> **CAUTION:** **If the hard disk has been reformatted due to database corruption, do not restore backups that were made during the corruption period otherwise corruption can occur again.**

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16.2 RECIPE AND SEQUENCE INTEGRITY

In order to maintain recipe and sequence integrity, *you cannot delete, overwrite, or alter Scan recipes or Sequence programs unless you also delete all data collected with them.* (You can change cursor positions, however, without deleting all the data.) If you attempt to save a recipe or program with an existing name, you will be prompted to rename it.

16.3 ERROR MESSAGES

The Tencor P-2 contains the following error messages (listed alphabetically). Whenever a message appears, it is followed by the line:

PRESS ANY KEY TO CONTINUE

"Continue" means to clear the current message from the screen and take recovery actions. It does not mean to continue processing in spite of the error.

386MAX Error:
A privileged operation exception has occurred at address xxxx:yyyy
An error has occurred in system software (operation system, device driver, or BIOS), possibly because of incorrect software or hardware configuration.
Press the RESET button to reset the instrument. If the problem persists, contact Tencor Service for computer system diagnosis.

386MAX Error:
A stack fault has occurred at address xxxx:yyyy
Internal hardware signals have caused system stack errors. The two most likely causes are an adapter board with a noisy interrupt line or one that is too slow for the computer motherboard.
Press the RESET button to reset the instrument. If the problem persists, contact Tencor Service for computer motherboard and BIOS reconfiguration.

Aborted by operator
This is a SECS upload or download error message. The operator pressed ESC or STOP before the SECS transaction was completed.
Try again.

Another file with same name exists! Overwrite? [Y/N]
The entered filename already exists in the chosen export path.
You can delete the old file by pressing YES or abort the operation by pressing NO.

At least two selections required for combining
You tried to combine a single sequence result in the Combined Statistics Option. You must select two or more sequence results for combining.

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Attempt to delete protected item
If this message appears when you attempt to delete a Scan recipe or Sequence program, it means that the item has been used to take data.
Delete all the data taken by the Scan recipe or Sequence program and then delete the item. If this message appears when trying to delete an item in the Database catalog of the Database Manager Option, it indicates a corrupted database. Restore the database from the last backup (see Section 18.2.6, "Database Recovery").

Attempt to format fixed disk
You attempted to format the hard disk, which has probably caused memory corruption.

Backup session is suspended
You have chosen to suspend the backup session, presumably because you have run out of formatted diskettes.
Get the required formatted diskettes and complete the backup operation *before performing any operation* in the database, the TENCOR directories, or subdirectories.

Backup volume has been removed. Please replace the same volume
The diskette has been removed from the drive while the backup or restore operation was in progress.
Replace the diskette. Note: If the diskette is not replaced as requested and if the backup operation was in progress, the backup will be incomplete. If the diskette is not replaced and the restore operation was in progress, you might get "Item not found" error messages when accessing the restored items.

Bad Command or File Name
The program was unable to locate the required system, program, or utility files.
Verify that the path statement in your AUTOEXEC.BAT file includes the names of the directories containing the program, utility, and system files. Verify that the installation program loaded all the program, utility and system files into their respective directories. See Chapter 15, "Offline P-2 Program."

Bad longwave cutoff filter value
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or recipe.

Bad or missing start/continue record
The backup file has been corrupted.

Bad parameter descriptor value
Bad shortwave cutoff filter value
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or recipe.

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Calibration Factor limited to .95 to 1.05!
You tried to enter a value for the New Calibration Factor that was out of range. Enter a step height calibration factor that is between 0.95 and 1.05.

Cannot combine, no statistics found, skipping this item
One of the sequence results selected for combining does not have any statistics results and will be skipped.

Cannot find font file MICPRINT.FY! Required system files are missing!!!
The system files are not located in the proper directory; these files must be loaded in the SYS directory under the root directory (C:\SYS).

Cannot open file
One of the Tencor P-2 system or data files has been deleted or write-protected.
If this message appears during the export operation of the Database Manager Option, select another filename that is not currently in use. If the same error occurs on the second filename as well, then the trace data file has been deleted.
If this message appears during any other time and you do not have a choice of selecting another filename, you must find the write-protected file and make it writeable using the DOS ATTRIB command.
If this message appears at start-up, you might have lost a system file and possibly all recipes, sequences, and data that have not been backed up.
Exit to DOS, reboot the instrument, and check the hard disk using DOS commands or other tools. Then check for the presence of the required files.

Cannot overwrite sequence data
To prevent the accidental overwriting of sequence data, you are unable to overwrite a sequence data item with a single scan item. For your convenience, however, you can overwrite sequence data with other sequence data and overwrite single scan data with any type of data.

Cannot save raw trace
There is not enough space on the designated disk path to save the raw trace data. The scan summary has already been saved.

Cannot save sequence data
You tried to save sequence data but did not save the modified Sequence program. Although the save operation has been aborted, the sequence will continue to run. To prevent this error, always save a modified Sequence program before pressing START, or rename, or overwrite the Sequence program when prompted after pressing START.

Checking diskette?:
Please do not remove
This is a status warning message that appears during backup or restore operations. Both of these operations take a long time and it is easy to miss the disk activity light.
Do not remove the diskette during this message.

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Combined items were not saved successfully
There was an error in saving the combined data.
Try again.

Communication failure
This is a SECS upload or download error message. If you were downloading data, then a SECS T2 or T3 timeout has occurred. The host did not respond to the Tencor P-2, or a data error was detected.
Confirm that the SECS link is communicating and try again.

Convert scan data for SECS failed
The data conversion to the SECS format (byte order) has failed and transmission has been aborted.

Could not delete unsuccessful export file
If the program cannot export the data, it will try to delete the file opened for export. This message indicates that the program could not delete that file and the file will remain in the EXP directory of the selected path. The file to which you are trying to export can be deleted from DOS. See Section 18.2.3, "Erasing a File," for more information on deleting files from DOS.

Current record is locked
Current record is not locked
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (the dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Current record is wrong record or type
Current selection criteria invalid
A software bug has been triggered within the Database Manager Option.
Exit to DOS and reboot the instrument. Restore the database from the last backup (see Section 18.2.6, "Database Recovery," for procedures). If the error persists, contact Tencor Service.

Cursors too close to each other
In auto-mechanical leveling, the slope of the trace is calculated between the leveling cursors. If you position the cursors too close to each other, the program cannot calculate a reliable slope.
Reposition the cursors farther apart.

Data already exists, rename?
Data already exists under the selected or default ID.
Press YES to rename the new data and avoid deleting the data currently stored.

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Data already exists, overwrite?
Data already exists under the selected or default ID. You chose not to rename the data, so the program is verifying your response to avoid overwriting the currently stored data. Press YES to overwrite the data or NO to abort the operation.

Database error
This is a SECS upload error message. The Tencor P-2 could not extract the recipe or sequence from the database, which could indicate database corruption.
Try again, or fix the database.

Database in use by another process
Reboot the instrument.

Database auto-recovery in process
Database file record limit exceeded
Database in use by another process
Database debug check interrupt
Database lock manager synchronization error
Database network communications error
Database not closed
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Data file not found
The filename entered for the import file does not exist. Check the pathname set to access the file or press F1 to display the directory of available import files.

Data has not been imported
The program could not import the data. This message is usually preceded by another message that should clarify the cause of the problem.

Data has not been exported
The program could not export the data. This message is usually preceded by another message that should clarify the cause of the problem.

Data not available, can not save
The data screen was blank when you tried the save operation.

Data not available or data not found
You attempted to recall data that does not exist, or you tried to display the Summary window when there was no trace displayed in the Data screen.
Recall data from the Database catalog or scan a sample before calling up the Summary window. If the error occurred from the menu item Data/Recall, you might have incorrectly entered the ID. If it occurred in the Database catalog, there might be data storage subsystem corruption, which is usually limited to one or a few specific items.

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Data pathname too long
A software bug has been triggered in the Database Manager Option.
Exit to DOS and reboot the instrument. Restore the database from the last backup (see Section 18.2.6, "Database Recovery," for procedures). If the error persists, contact Tencor Service.

Deskew field values are invalid
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or recipe.

Different number of traces in SUM_DATA
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

Directory file did not close
No import files are available in the selected path. If you are sure that there are files in the selected path, contact Tencor Service.

Disk file error! Cannot overwrite
The export file is either write-protected or cannot be deleted. Enter another filename.

Duplicate user ID
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Empty directory
You called up the Recipe or Database Catalog window when the catalog was empty.

ERROR. Cannot find Expanded Memory.
Your personal computer was unable to access the expanded memory either because the CONFIG.SYS file was unable to set up the expanded memory properly, or the previous program used TSR (terminate and stay resident) memory.
Check to make sure that the device drivers are configured properly and that CONFIG.SYS can find them. If the error persists, press RESET to reset the computer and clear the memory.

Error: Closing raw data file
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

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Error: File not saved
You tried to save data to the wrong diskette or to one that was defective.

Error : number of stat_entries in two samples are not same
This error message could indicate a corrupted Sequence program or database.
Abort the operation. Delete the Sequence program and try again with another Sequence program. If the problem continues, the database might be corrupted. Restore the database from the last backup. See Section 18.2.6, "Database Recovery," for procedures.

Error: Index table indicates 0 trace size
Error opening raw data file
Error: Total traces=0
Indicates a severe internal software problems.
Exit to DOS *immediately* and contact Tencor Service.

Errors in finding recipes
You tried to retrieve a recipe from a diskette that did not contain the recipe or from one that was defective; or you tried to save a recipe to the wrong diskette or to one that was defective.

Error in standard deviation calculation
Internal software error.
Exit to DOS and report to Tencor Instruments.

Error seeking database file
Error reading from a database file
Error writing to a database file
Each of the above messages indicates a problem with a database file in the Database Manager Option.
Exit to DOS and reboot the instrument. Restore the database from the last backup (see Section 18.2.6, "Database Recovery," for procedures). If the error persists, contact Tencor Service.
If any of the above error messages appear during a backup operation, exit to DOS and reboot the instrument. Repeat the operation again with a different set of backup diskettes. If the error persists despite a different set of diskettes, your database has been corrupted. In this case, exit to DOS, reboot the instrument, and restore the database from a previous backup (see Section 18.2.6, "Database Recovery," for procedures) and continue.

Error in Number of Recipes in Sequence Program
This error message could indicate a corrupted Sequence program or database.
Abort the operation. Delete the Sequence program and try again with another Sequence program. If the problem continues, the database might be corrupted. Restore the database from the last backup. See Section 18.2.6, "Database Recovery," for procedures.

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Exceeded max list size - can not select any more items
You tried to select more than 25 sequence data results for the Combined Statistics Option. You can select up to a maximum of 25 sequence results.
To combine more than 25 sequence results, first combine 25 sequence results. Then, combine the result of the first 25 with the next 24 sequence results and so on.

Exceeded physical limit
In auto-mechanical leveling, the instrument calculates the slope of the trace and drives the leveling motor to counter this slope. This error message appears when the slope of the trace causes the leveling motor to be driven outside of its limits.

Existing recipe has data, rename?
You attempted to overwrite a previous recipe, and the recipe has data taken with it. Press YES to rename the recipe being saved or NO to abort the operation.
Note: You must save the recipe if you want to save data taken with it.

Existing sequence has data, rename?
You attempted to save a Sequence program under a name already used for another Sequence program. You cannot overwrite the old Sequence program because data has been taken and saved with it.
Press YES to rename the sequence or NO to abort the operation.

Export field values are invalid
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or recipe.

Export file already open
The export file was already open when you attempted to open it. This indicates an internal software problem or a DOS file system problem.
Exit to DOS and reboot the instrument.

Export file did not close
DOS failed to close the export file. This can indicate a DOS file system error but probably is an internal software problem.
Exit to DOS and reboot the instrument.

Extension file did not close
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

Failed to open backup file
There is a problem with the disk media or formatting.
If you were trying to back up data, use another diskette.
If you were trying to restore the data, you cannot restore data from this diskette using the Tencor P-2 software.
(Note: You could try restoring the diskette using one of the commercially available utility programs.)

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File error! Cannot delete "%s filename" file.
There is an error in deleting an import file in the specified path.
Press F4 to quit the Import File Directory window and reopen the window again. If the error persists, contact Tencor Service.

File error - Cannot open directory
Internal software error.
Exit to DOS and reboot the instrument. Repeat the failed operation again. If the problem continues, contact Tencor Service.

File list is empty
No import files are available in the selected path. If you are sure that there are files in the selected path, contact Tencor Service.

File not found!
You tried to recall data with an ID that was not listed in the Data catalog.
From the menu bar, choose Data/Catalog and see if the desired data is stored there.

File read error
Either a data file is corrupted or not present, or a condition similar to "File Seek Error" has occurred.
Exit to DOS, reboot the instrument, and check the hard disk.

File seek error
The most probable cause of this error is file system run-time corruption. The hard disk also might have been corrupted.
Exit to DOS, reboot the instrument, and check the hard disk using DOS commands or other tools.

File write error
Either there is insufficient disk space or a condition similar to "File Seek Error" has occurred.
Exit to DOS, reboot the instrument, and check the hard disk using DOS commands or other tools.

Heap is damaged - Press RESET
Heap is empty - Press RESET
Each of the above indicates a hardware or software problem, and the program will not operate.
Exit to DOS and reboot the instrument. If this error occurs repeatedly, contact Tencor Service.

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Host busy
This is a SECS upload error message. This is a host-generated condition. The host was unable to accept the recipe or sequence because it was busy.
Try again later.

Host busy
This is a SECS download error message. The host has acknowledged but will not accept the EquipmentPpType (S7F65).
Try again.

Host message item format
This is a SECS upload error message. The host has sent a SECS message with an incorrectly formatted item.
Correct the host message and try again.

Host permission not granted
This is a SECS upload error message. This is a host-generated condition. The host will not accept a multiblock (that is, sequence) SECS message at this time.
Try again.

Host will not accept
This is a SECS upload error message indicating a host-generated condition. The host was unable to accept the recipe or sequence for a reason other than being busy.
Try again.

Illegal argument to database function
Illegal ID or ID combination
A software bug has been triggered within the Database Manager Option.
Exit to DOS and reboot the instrument. Restore the database from a previous backup (see Section 18.2.6, "Database Recovery," for procedures) and continue. If the error persists, contact Tencor Service.

Illegal ID
Illegal profile type
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or recipe.

Illegal record type in backup file
The backup file has been corrupted.

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Import file already open!
The import file was already open when you attempted to open it. This indicates an internal software problem or a DOS file system problem.
Exit to DOS and reboot the instrument.

Import file did not close
The DOS program failed to close the import file. This indicates an internal software problem or a DOS file system problem.
Exit to DOS and reboot the instrument.

Incorrect recipe, cannot import
The recipe that you are trying to import might be corrupted, have bad parameters, or is an old version that cannot be saved or viewed. You will not be able to import this recipe.

Incorrect Recipe or Sequence ID from host
This is a SECS download reply error message. The recipe or sequence ID downloaded by the host with the Process Program body does not match the ID requested.
Try again.

Incorrect vertical range
You tried to perform a step height calibration in a vertical range that differed from that of the current Calib recipe. Each vertical range must be calibrated independently.
For example, if a scan has been performed using the CALIB13 recipe, choose the 13 μm range in the Calibration window and press [F1: Calibrate]. Then switch to the CALIB300 recipe, perform another scan, and calibrate the 300 μm range. (Refer to Section 17.9.1, "Calibration Factor (Step Height Method).")

Index table error - Wrong file offset
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

Insufficient space on drive
A preliminary check of drive space indicated that there was not enough space to save the item.

Internal data access software error
There was a software problem or minor data storage run-time system corruption. If this occurred during a save operation, the item was probably not saved.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

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Internal stack overflow error
Internal hardware signals have caused system stack errors. The two most likely causes are an adapter board with a noisy interrupt line or one that is too slow for the computer motherboard.
Press the RESET button to reset the instrument. If the problem persists, contact Tencor Service for computer motherboard and BIOS reconfiguration.

Invalid country table sort string
Invalid database file specified
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Invalid data access path
A software bug has been triggered in the Database Manager Option.
Exit to DOS and reboot the instrument. Restore the database from a previous backup (see Section 18.2.6, "Database Recovery," for procedures) and continue. If the error persists, contact Tencor Service.

Invalid host Process Program type
This is a SECS upload error message.
Contact Tencor Instruments.

Invalid PPID.
This is a SECS upload error message. A recipe or sequence ID with an invalid character was selected. This indicates database corruption.
Save the recipe or sequence under a new ID that has valid characters and try again.

Invalid recipe, 3D is not installed
You cannot import 3-D recipes if your instrument does not have the 3-D Option installed.

Invalid Recipe or Sequence ID
This is a SECS download return error message. A recipe or sequence ID entered by the operator contains invalid characters.
Enter the ID again with correct characters and try again.

Invalid SECSAutoDataSend value
The Equipment Constant SECSAutoDataSend has been set to an invalid value; valid values are 0, 1, and 2. Edit the value from the Configure/SECS menu.

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Invalid item
Invalid color banding for 3D scans
Invalid sample rate
Invalid sample rate for P2 at this speed
Invalid segmentation number
Invalid sequence X-Y position value
Invalid sequence theta position value
Invalid size for number of locations
Invalid SORT_FAIL_LOC value
Invalid SORT_PARAM ID code
Invalid SORT_PARAM OL_ENA value
Invalid SORT_PARAM OL_PASS_PCT value
Invalid SORT_PARAM R_ENA value
Invalid SORT_PARAM SD_ENA value
Invalid SORT_PARAM X_ENA value
Invalid SORT_PASS_LOC value
Invalid SORT_PRT value
Invalid SORT_SAVE value
Invalid speed
Invalid stylus drop speed
Invalid stylus force
Invalid stylus radius
Invalid WAFER ALIGN_ANGLE value
Invalid WAFER ALIGN_FEATURE value
Invalid WAFER CASS_BITMAP value
Invalid WAFER LD_SRC value
Invalid WAFER MODE value
Invalid WAFER NUM_RAND value
Invalid WAFER UNLD_SRC value

All of the above error messages indicate that you tried to import a corrupted Sequence program or Scan recipe.
Try importing another copy of the Sequence program or recipe. If the error persists, delete the Sequence program or Scan recipe.

Item already exists
You tried to store an item with the same ID name as one already stored.
Choose a different ID name and continue.

Item is invalid for target instrument type
One of the fields is invalid for the instrument in use but might be valid for other Tencor Instruments products.

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Item is invalid for target instrument configuration
You selected an item for which the option is not installed but the Sequence program and Scan recipe have fields assigned for it.

Item was not found
The item sought was not present. This can be caused by an internal software problem or by corruption of the data storage files or run-time subsystem. This also can occur when an item is being saved, because searches for duplicates occur at that time. If the error occurred while saving data, a Scan recipe, or a Sequence program, the item probably was not saved.
Reboot the instrument.

Keylocked operation
You tried to perform an operation when the keylock was set to a lower position than required for the operation.

Matrix overflow on host
This is a SECS upload error message. This is a host defined error (ACK7 = 3).
Correct the error condition on the host and try again.

Maximum file size exceeded
This is most likely to result from an internal memory or file system run-time corruption. Reboot the instrument. If the condition persists after reboot, the Tencor P-2 system files might be corrupted.

Memory allocation
If you are using the SECS Option, this is a SECS upload or download error message. The Tencor P-2 did not have enough memory to handle the Scan recipe or Sequence program. Disable some of the software features to increase the amount of available memory.

Memory allocation error
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

Memory contents corrupted
There was a software problem or minor data storage run time system corruption.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Reboot *immediately*. If the problem continues, contact Tencor Service.

Memory error, left=XXK, needed XXX bytes
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

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Message item format
This is a SECS upload or download error message. A message from the host was incorrectly formatted.
Correct the host message and try again.

Message length
This is a SECS upload error message. This is a host-defined error (ACK7 = 2).
Correct the error condition on the host and try again.

Mismatch filename - Delete error in DIR-file. Press F4 key and quit.
This message is displayed if there is an error in deleting an import file in the specified path.
Press F4 to quit the Import File Directory window and reopen the window again. If the error persists, contact Tencor Service.

Mode field values are invalid
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or Scan recipe. If the error persists, delete the Sequence program or Scan recipe.

Mode unsupported on host
This is a SECS upload error message. This is a host defined error (ACK7 = 5).
Correct the error condition on the host and try again.

Motion error: Limits exceeded
Excessive power was used to move the stage.
Turn the power off, wait for 10 seconds, and check for a mechanical obstruction. Then turn on the power. If this message appears repeatedly, contact Tencor Service.

Must rename recipe to save data, OK?
You attempted to take a scan with an unsaved recipe that has the same name as another recipe.
Press YES to display the Alphanumeric window and rename the recipe. Press NO to abort the data save operation. If you rename the current recipe, the program will automatically save it in the Recipe catalog under the new name.

Must rename sequence to save data, OK?
You attempted to take a scan with an unsaved Sequence program that has the same name as another program.
Press YES to rename the Sequence program. If you press NO, the sequence will run, but no data will be saved.

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No database lock manager is installed
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

No files found - Cannot import any file
No import files are available in the selected path. If you are sure that there are files in the selected path, contact Tencor Service.

No IDs found
You have not created any ID values under this ID level.
You can create a new ID value if you wish to save the data under a new ID value at this ID level.

Not enough disk space
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

Not enough memory or insufficient memory
Generally, this message appears in one of the catalog windows and can indicate that too many items of the particular type have been saved. The catalog windows can handle approximately 2500 data items or sequences (which fill about 40 screens) and approximately 200 recipes (about 10 screens). This condition will not occur without prior warnings.
Exit to DOS, reboot or restart the program, and attempt to repeat the failed operation immediately after starting.

Obsolete data formats
The Tencor P-2 software might have been installed incorrectly; this message should only occur if the database dictionary is not the correct version for the software using it. Exit to DOS and verify that the default directory is C: \TENCOR and that the database dictionary file P1DBASE.DBD is present and has the same date and size as on the program disk.

Only binary files can be imported
The import facility in the Database Manager Option is available for binary files only. This message, however, indicates an error in the software or the DOS file system. Reboot the instrument and attempt to repeat the failed operation immediately after starting. If the same problem occurs, call Tencor Service.

Operation busy - Cannot save
Indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

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Option not installed
You attempted to perform an operation that has not been installed on your instrument or has not yet been implemented in the software or hardware.

Out of disk space
There is not enough space left on the hard disk or diskette to store the item that you attempted to save. This message generally occurs when exporting files to diskette, particularly with a sequence data item that is too large to fit on a diskette.
Purge some of the items (preferably raw data items) in the database and try to save the item again.
If this message occurs other than during an export to diskette, and there has not been a history of "Insufficient Memory" or "Not Enough Memory" errors while accessing one of the catalogs, the hard disk file system might be corrupted.
Exit to DOS and check the hard disk using DOS or other tools.

Outside of circular limits
You tried to enter values for the Load or Measurement positions that were outside of the 210-mm (8.2-in.) circle.
Enter values that are within the limits.

Parity error
A bit at a system memory location has spontaneously switched or is stuck at one value.
Press the RESET button to reset the instrument. If the problem persists, contact Tencor Service for computer system diagnosis.

Please verify scan length and/or scan speed
Max scan length = 210 mm / 8.2 inch
Max scan time = 100 seconds
Scan length must not be greater than 210 mm (8.2 in.). Scan time must not exceed 100 s. You cannot continue until the scan length, time, or number of segments is corrected. If you get a message with a segmented scan, check the number of segments entered and that the *total* length of the segments does not exceed 210 mm.

Print field values are invalid
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or Scan recipe. If the error persists, delete the Sequence program or Scan recipe.

Reading from diskette?:
Please do not remove
This is a status warning message that appears during the restore operation. This operation takes a long time and it is easy to miss the disk activity light.
Do not remove the diskette during this message.

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Record has been deleted
Record has been updated
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Recipe already exists, overwrite?
You attempted to save a recipe with a name that has already been used.
Press YES to save the current recipe and delete the previous one. The save operation will be aborted if the previous recipe had data taken with it.

Recipe has not been exported
The program could not export the recipe. This message is usually preceded by another message that should clarify the cause of the problem.

Recipe has not been imported
The program could not import the recipe. This message is usually preceded by another message that should clarify the cause of the problem.

Recipe not found
You tried to recall a recipe that is not stored in the Recipe catalog. If this error occurred while the Recipe catalog was displayed, it indicates possible Tencor P-2 data storage subsystem corruption.
From the menu bar, choose Catalog from the Recipe menu and see if the desired recipe is stored in the catalog.

Recipe/Sequence ID not found
This is a SECS upload error message. This is a host defined error (ACK7 = 4). The Recipe or Sequence ID was not found on the host.
Correct the error condition on the host and try again.

Recipe or Sequence already exists
This is a SECS download error message. The Scan recipe or Sequence program requested by the operator already exists on the Tencor P-2 hard disk.
Delete the requested Recipe or Sequence and try again.

Recipe or Sequence request denied by host
This is a SECS download reply error message. This is a host-generated condition. The host could not send the requested Process program. The host might not have one with the ID requested, or it is private.
Confirm that the host has the requested recipe or sequence and try again.

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Reply: <Reply Parameter>
This is a SECS upload error message. An unknown error condition was detected. Contact Tencor Instruments.

Restoration aborted. Database may contain incomplete items.
This message should be ignored if you never actually read data from a backup diskette. Otherwise, the incomplete items might cause "Item not found" error messages when recalled, sequence results might not contain all the scans, or scan traces might be missing even though the summaries are present.

Save field values are invalid
You tried to import a corrupted Sequence program or recipe.
Try importing another copy of the Sequence program or Scan recipe. If the error persists, delete the Sequence program or recipe.

SECS get data array size error
SECS get data conversation error
SECS get data item error
SECS get data size error
SECS get type error
The Tencor P-2 has failed to read an incoming message.

SECS put data array size error
SECS put data type error
The Tencor P-2 has failed to assemble an outgoing message.

SECS transmission aborted
This message is confirmation that the measurement data upload has been aborted by the local operator.

Seek error in delete. Press F4 key and quit.
This message is displayed if there is an error in deleting an import file in the specified path.
Press F4 to quit the Import File Directory window, and reopen the window again. If the error persists, contact Tencor Service.

Selected item SEQ.ID must be same as the SEQ.ID of previous item
You tried to combine sequence results with different Sequence IDs. All the selected sequence results must have the same Sequence ID.

Sequence already exists, overwrite?
You attempted to save a Sequence program under a name already used for another Sequence program.
Press YES to save the new Sequence program and to delete the previous one. The save operation will be aborted if the previous Sequence program had data taken with it.

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Sequence data not found
This message indicates that no scan data or statistics have been saved for a sequence although the sequence was started. The most likely cause is a sequence being aborted after the data save prompt but before the first scan was completed.

Sequence not found
You attempted to recall a Sequence program that does not exist. If the error occurred as a result of recalling from the Sequence/Recall menu, it indicates that you entered the ID incorrectly. If the error occurs in the Sequence catalog, it can indicate data storage subsystem corruption. Contact Tencor Instruments.

Sequence Program has not been exported
The program could not export the Sequence program. This message is usually preceded by a message clarifying the cause of the problem.

Sequence Program has not been imported
The program could not import the Sequence program. This message is usually preceded by another message that should clarify the cause of the problem.

Sort utility not installed
You tried to import a sequence with the sort option enabled. Your instrument software does not have the sort utility installed.

Status: <Status>
This is a SECS upload or download error message. An unknown error condition was detected.
Contact Tencor Instruments.

Stylus offset not found
A problem has occurred during the stylus offset calibration that has stopped the calibration sequence; therefore, the stylus offset value was not found.
Contact Tencor Service.

The database lock manager is busy
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Too many backup volumes
There are 1000 or more backup volumes (diskettes or cartridges) in the current session.

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Too many changed database pages
Too many database users
Unable to lock database transaction file
Unable to read database transaction file
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Two stat_entries do not match - terminating this operation
This error message could indicate a corrupted Sequence program or database.
Abort the operation. Delete the Sequence program and try again with another Sequence program. If the problem continues, the database might be corrupted. Restore the database from the last backup. See Section 18.2.6, "Database Recovery," for procedures.

Undefined heap status - Press reset
There is either a hardware or software problem, and the program will not operate.
Reboot the instrument. If this error occurs repeatedly, contact Tencor Service.

Unknown item type
Internal database error.
Exit to DOS and reboot. If the same error persists, call Tencor Service.

Unspecified user ID
A software bug has been triggered within the Database Manager Option.
If possible, note the code number (a dash or minus is significant) and register a software problem report with Tencor Service.
Exit to DOS (if possible) and reboot the instrument immediately.
If the problem continues to affect your ability to use the instrument, call Tencor Service.

Wafer handler not installed
You attempted to access an option that requires the wafer handler to be installed.
If the wafer handler is installed, call Tencor Service.

Writing export file
This is a warning that the export file is being written.

Writing to diskette?:
Please do not remove
This is a status warning message that appears during the backup operation. This operation takes a long time and it is easy to miss the disk activity light.
Do not remove the diskette during this message.

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Write error in delete. Press F4 key and quit.
This message is displayed if there is an error in deleting an import file in the specified path.
Press F4 to quit the Import File Directory window and reopen the window again. If the error persists, contact Tencor Service.

Wrong function call - Operation is unsuccessful
Wrong trace number
Each of the above messages indicates a severe internal software problem.
Exit to DOS *immediately* and contact Tencor Service.

XBIOS checksum error
A driver or third-party program has written into the Extended BIOS Setup memory, invalidating the checksum. This problem is known to occur with certain motherboards when the Epson-IBM High-Resolution printer driver is installed (option 4 in the Printer Selection window).
Select another printer driver (option 1 generally) in the Printer Selection window (see Section 2.2.8, "Configuring the Tencor P-2 for your Printer," for details) and contact Tencor Service for Extended BIOS reconfiguration. If you are experienced in dealing with computer systems, you can reconfigure the Extended BIOS yourself by accessing the Extended BIOS Setup. There are no known instances of changes in valid settings as a result of this problem.

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17 HARDWARE MAINTENANCE

17.1 TROUBLESHOOTING

17.1.1 SERVICE POLICY

The Tencor Instruments Service Organization is available to you in the United States, Europe, and Japan. We also have representatives in Taiwan, Singapore, and Korea.

Our commitment is to provide a technical response by telephone within 24 hours, often within the same business day. Our commitment for on-site repair is 48 hours.

- Our service organization is available for unpacking and installing your instrument. To schedule the installation, complete the Preinstallation Qualification Form supplied to you by Tencor Instruments and contact the Customer Service Administrator at (800) 722-6775.
- In the United States we handle all service requests through a central number located in California. Call (800) 722-6775 Monday through Friday between 6:00 A.M. and 6:00 P.M. Pacific Standard Time to arrange for service or repair work or to order replacement parts.
- Standard on-site service hours are Monday through Friday, 8 A.M. to 5 P.M. local time. You can arrange for other hours through a customized service contract.
- We provide service beyond the original warranty period of 1 year as needed. Repair work that is done after the original warranty expires is guaranteed for 3 months. Full service contracts extend the warranty period and can be customized to your specific requirements.

We encourage you to attend a maintenance and repair training course for your instrument. In general, we find that better trained customers experience greater instrument up-time and make better use of our service resources. Your sales or service engineer can provide you with the course and fee schedule.

17.1.2 DIAGNOSTIC SCAN

A diagnostic scan differs from a normal scan in that the stage does not move. The diagnostic scan helps determine how much the operating environment is contributing to the noise level. By examining the TIR results after a diagnostic scan, you can rate the quietness of the environment. This scan is designed to eliminate any contributions to noise from the sample surface that is being scanned and from mechanical noise from operation of the instrument.

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To perform a diagnostic scan:

1. Choose Scan from the Diag menu and press ENTER to display the following window:

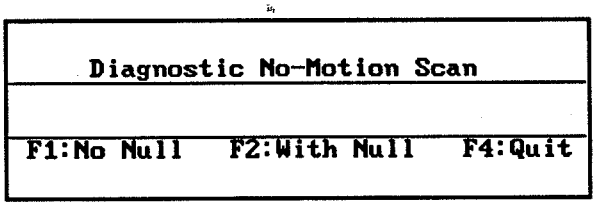


Figure 17-1 Diagnostic Scan

2. Press [F1: No Null] to scan without a sensor nulling operation to prevent the elevator from moving. Or, press [F2: With Null] to allow a nulling operation if required before the scan. The null position is the position of the stylus when it is midway between its highest and lowest limits, i.e., the stylus arm is horizontal and the readout is approximately 0.

   The Scan screen is displayed followed by the Data screen showing the trace.

17.2 CHANGING THE STYLUS

> **NOTE:** **If you have the optional MicroHead instead of the standard measurement head, refer to Section 9.4, "Changing the MicroHead Stylus," or Section 9.5, "Changing the Extended Range MicroHead Stylus," for instructions on changing the MicroHead L-stylus.**

Replacement styli of several sizes are available from Tencor Instruments. Verify the radius of the stylus in place by checking the color band on the stylus shank. See Table 17-1 for more information.

Table 17-1 Determining the Stylus Radius

Stylus Radius (μm)	Shank Angle (Deg.)	Color Band
50	60	White
25	60	Blue
12.5	60	Red
5.0	60	Yellow
1.5 – 2.5	60	Green
1.5 – 2.5	45	Orange
0.1 – 0.8	70	Black

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Two ways of changing the stylus are detailed below.

17.2.1 CHANGING THE STYLUS USING TWEEZERS

NOTE: **Be very careful when changing the stylus. The Tencor Instruments Warranty Policy does not cover damage to the stylus assembly or the pivot caused by operator error or carelessness when changing the stylus.**

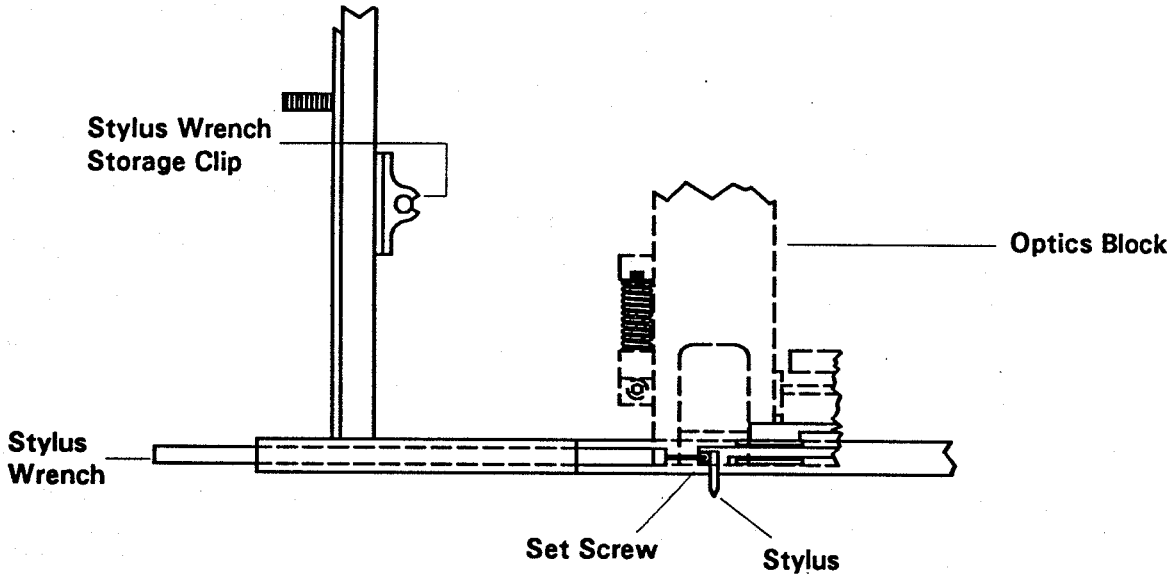


Figure 17-2 Replacing the Stylus Using Tweezers

To change the stylus using tweezers:

1. Press ZΘ and [↑] to raise the measurement head for working clearance.
2. Press [↓] to lower the stylus.
3. To avoid losing the stylus if you accidentally drop it, place a container with a mirror underneath it before starting.
4. Open the door in front of the measurement head. To the left of the optics block, find the tip end of the stylus arm and the stylus clamping setscrew.
5. Press ZΘ to display the Motion screen (see Fig. 6-20) and press [↓] to lower the sensor assembly all the way down.
6. The stylus wrench is stored in a clip on the left side of the measurement head (Fig. 17-2). Pull the stylus wrench out of the clip and insert it into the guide hole on the left of the base plate of the measurement head.

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7. Slide the stylus wrench through the guide hole parallel to the stylus arm (it might be helpful to remove the right side panel to make it easier to see). Turn the wrench counterclockwise slowly while gently pushing on it to insert the wrench into the setscrew. *Be careful not to use too much force.* If necessary, position the stylus arm vertically using a finger.

8. Loosen the setscrew and extract the stylus from its socket using tweezers. Be careful not to loosen the set screw so much that it falls out, as it will be difficult to replace it. *Leave the wrench engaged to steady the arm while replacing the stylus.*

10. Hold the replacement stylus with the tweezers and carefully insert the stylus. Be certain that the stylus is inserted in the hole as far as possible and gently tighten the setscrew so as to just hold the stylus in place. *Do not tighten it too much because the threads might strip or damage the sensor arm pivots.*

11. To insure that the stylus is fully inserted, place a finger under the stylus tip and loosen the set screw. Gently press upwards with your finger on the stylus tip until the stylus is fully seated. Gently retighten the setscrew. *Do not tighten it too much because the threads might strip or damage the sensor arm pivots.* Note: If the stylus is not fully seated, the stylus will not appear centered on the viewing screen.

12. Remove the stylus wrench from the measurement head plate and insert it into its storage clip on the left side of the measurement head.

CAUTION: Failure to remove the wrench could lead to instrument damage if the wrench is accidentally bumped and pushed into the stylus arm.

13. If the instrument is normally used at stylus forces below 5 mg, recalibrate the stylus force offset. Refer to Section 17.9.4, "Stylus Force Offset."

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17.2.2 CHANGING THE STYLUS USING PLASTIC FORCEPS

> **NOTE:** Be very careful when changing the stylus. The Tencor Instruments Warranty Policy does not cover damage to the stylus assembly or the pivot caused by operator error or carelessness when changing the stylus.

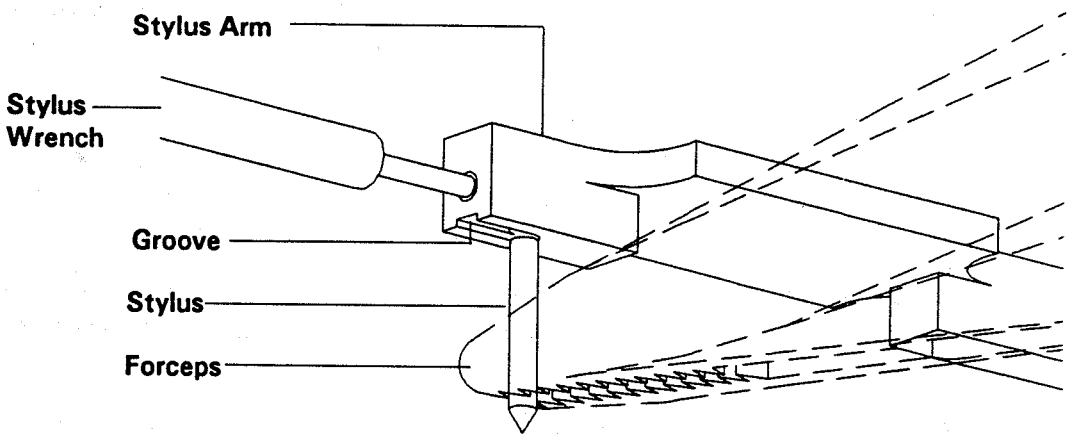


Figure 17-3 Replacing the Stylus Using Plastic Forceps

To remove the stylus:

1. Raise the measurement head and move the stage back to provide working clearance.
2. Press Z0 to display the Motion screen and use [↓] to lower the sensor.
3. The stylus wrench is stored in a clip on the left side of the measurement head (Fig. 17-2). Pull the stylus wrench out of the clip and insert it into the guide hole on the left of the base plate of the measurement head.
4. Slide the stylus wrench through the guide hole parallel to the stylus arm (it might be helpful to remove the right side panel to make it easier to see). Turn the stylus wrench counterclockwise slowly while gently pushing on it to insert the wrench into the setscrew. *Be careful not to use too much force.* If necessary, position the stylus arm vertically using a finger.
5. Grasp the stylus with your fingers and turn the wrench counterclockwise to loosen the setscrew. Remove the stylus downward. Be careful not to loosen the set screw so much that it falls out, as it will be difficult to replace it. *Leave the wrench engaged to steady the arm while replacing the stylus.*

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To install the new stylus:

1. Practice opening and closing the forceps. To close the forceps lock, press the handles together. To open the forceps lock, slip the handles sideways.
2. Open the forceps and lay the tip end of the stylus in the second or third groove from the tip of the forceps. Close the forceps. Note: Maximum length of the stylus should be visible over the forceps.
3. Hold the forceps so that the pointed end of the stylus is facing downward and insert the stylus into the stylus arm while looking at the arm directly or with a mirror; or
   Slide the stylus shank along the front of the stylus wrench (visible from the front) to the right until contacting the end of the stylus arm. Lower the stylus until the bottom of the stylus arm is reached and the groove and the stylus are engaged. Then slide the stylus to the end of the groove and insert the stylus.
4. Tighten the setscrew gently. *Do not tighten it too much because the threads might strip or damage the sensor arm pivots.* Slip the forceps handles sideways to release the stylus.
5. To insure that the stylus is fully inserted, place a finger under the stylus tip and loosen the set screw. Gently press upwards with your finger on the stylus tip until the stylus is fully seated. Gently retighten the setscrew. *Do not tighten it too much because the threads might strip or damage the sensor arm pivots.* Note: If the stylus is not fully seated, the stylus will not appear centered on the viewing screen.
6. Remove the stylus wrench from the measurement head plate and insert it into its storage clip on the left side of the measurement head.

CAUTION:	**Failure to remove the wrench could lead to instrument damage if the wrench is accidentally bumped and pushed into the stylus arm.**

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17.3 STYLUS TIP RADIUS MEASUREMENT

This procedure describes a method of inspecting the tip of a stylus to measure its radius or determine if it has been broken. This is done by profiling an apex with a radius much smaller than the radius of the stylus tip itself. The Tencor Stylus Radius Measurement Tool (Tencor Part No. 205958) consists of a razor edge mounted in a rectangular fixture. See Fig. 17-4.

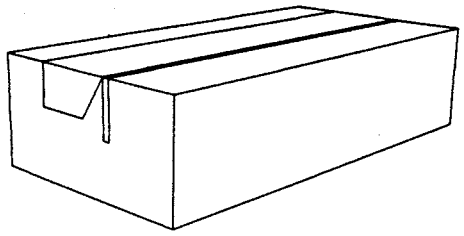


Figure 17-4 Tencor Stylus Radius Measurement Tool

To measure a stylus tip radius using the Stylus Radius Measurement Tool:

1. Enter the following recipe:

RECIPE

Recipe ID	: STY_RAD	V.Units	: Metric
Recipe Type	: 2D	V. Range/Res.	: 300um/25A
		Profile Type	:
Horizontal Units	: Metric	V. Display Scale	: Auto
Scan Length	: 120 um		
Scan Speed	: 5 um/s		
Scan Time	: 24 sec		
Sampling Rate	: 200 Hz	Graph	: Raw Data
Horiz. Res.	: 0.03 um	Long Wave Cutoff	: OFF
Direction	: ->	Short Wave Cutoff	: Default
		Fit & Level	: Off
Multi-Scan Avg	: 1 [1-10]		
Segmented	: No	Cursors: RELATIVE um	Left Right
		Measurement	: 20.00 100.00
		Leveling	: 0.00 0.00
		Delta Meas Width	: 0.00 0.00
Stylus Force	: 3.0 mg	Delta Level Width	: 0.00 0.00
Contact Speed	: 3		
Radius Required	: 0.0	Surface Parameters	View

F1:Save F2:Recall F3:Cursors F4:Quit

Figure 17-5 Recipe for Determining Stylus Radius

Make sure that you set the positions of the L and R leveling cursors to 0 to disable leveling and that the measurement cursors have a preset position. Set the Radius field in the Surface Analysis window to Display. Also set the Edge and Distance to Edge parameters to On or Display.

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NOTE:	If a scan length of 120 μm is too short to effectively make the scan, try Scan length: 240 μm Scan speed: 5 μm/s Samp. Rate: 100 Hz

2. Press X-Y or Z-Θ to display the Motion screen and position the stylus about 100 μm from the edge of the blade, as shown in Fig. 17-6. Note: It might be difficult to accurately determine the position of the edge by sight. If you have difficulty, try taking a longer scan to locate the edge, then adjust the start position accordingly and return to the shorter scan length. Null the stylus, then press START to take a scan. Figure 17-7 shows a typical profile.

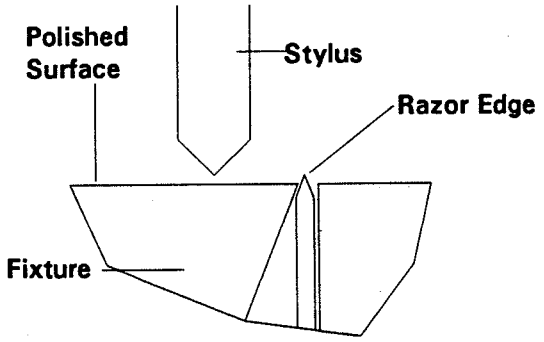


Figure 17-6 Positioning to Start Scan

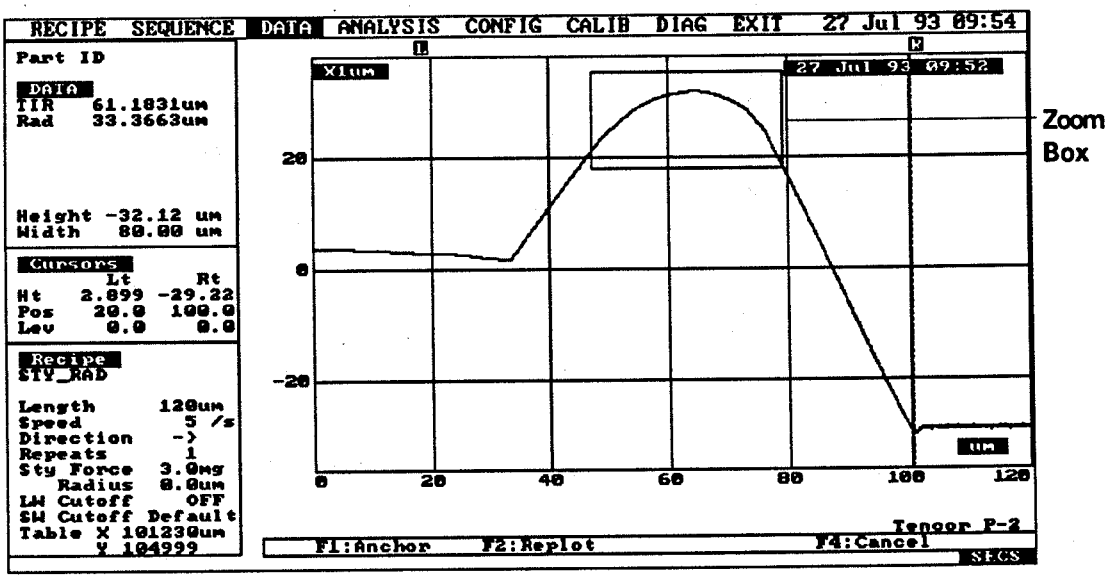


Figure 17-7 Typical Data From Scanning Stylus Radius Measurement Tool

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3. Zoom the trace to the area near the apex and position the measurement cursors on either side such that

   - The cursors clearly intersect the trace *on the curved portion* of the apex, not further away where the trace straightens out
   - The difference between the cursor heights is as close to 0 as possible

   The height difference should be less than 3% of the measurement width. This is the case if the sampling rate is 200 Hz and Automatic Cursor Positioning (set for Apex) is used. If you want to adjust the measurement cursors manually, be sure that you have zoomed in the Data screen as much as possible on the region of the apex. See Figure 17-8.

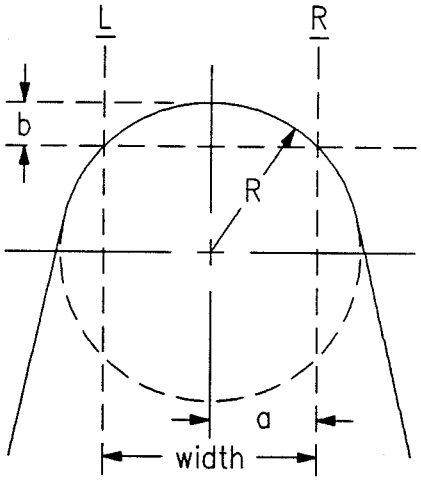


Figure 17-8 Cursor Positioning for Radius Determination

4. Read the Radius value from the summary box in the Data screen.

Stylus tips are not perfectly spherical; typically, the radius varies, being smallest at the tip and larger as the curve flattens out into the shaft. For features that are small enough, the effective radius of the stylus at the area where the tip contacts the sample surface will be smaller than it will be for larger features. If the value of *b* in Fig. 17-8 can be chosen as the TIR value of a typical measurement, then, the actual effective radius of the stylus at that scale can be more precisely stated.

During a scan, the stylus moves in a circular arc around the stylus arm pivot instead of a pure vertical motion. This produces a slight distortion in the profile. For practical purposes, this distortion is very small and can be ignored.

If the arc at the apex of the trace is noticeably flattened or misshapen, this could indicate a dull spot in the razor edge or a broken or misshapen stylus. Try taking the scan at a few other locations along the razor edge. If the apex of the trace appears much the same regardless of location along the razor edge, this indicates a flawed stylus.

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For more information about issues of stylus geometry and stylus characterization, refer to the material on "Stylus Geometry" in Section 19.2.1, "Step Height Measurements."

The Thin Film Step Height Standards listed in Appendix E have two stylus integrity tracks that allow diagnostic checks of the stylus condition (symmetry and cleanliness). For more information, see the VLSI Standards Application Note "Thin Film Step Height Standard," provided with the Step Height Standard.

CAUTION: **Do not touch the razor edge on the Stylus Radius Measurement Tool. To protect the razor edge from any contact with objects other than a stylus, return the tool to its storage case promptly after use. The method of stylus radius determination used is based on assuming that the razor edge has a radius much smaller than the stylus radius. Dulling of the edge will invalidate this approximation.**

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17.4 FOCUSING THE OPTICS

> **NOTE:** If you have the optional MicroHead instead of the standard measurement head, the optics block has a different appearance than Fig. 17-9, but the focusing screw is located in the same position as described below, and the optics are focused in the same way.

To refocus the optics if needed:

1. Null the stylus on the sample (a patterned sample with easily-defined features works well).
2. Locate a hex socket cap screw head to the left of the optics block approximately 0.5 in. above the bottom of the measurement head.
3. Use the 3/32-in. hex wrench, provided with the instrument, to adjust the focus as required.

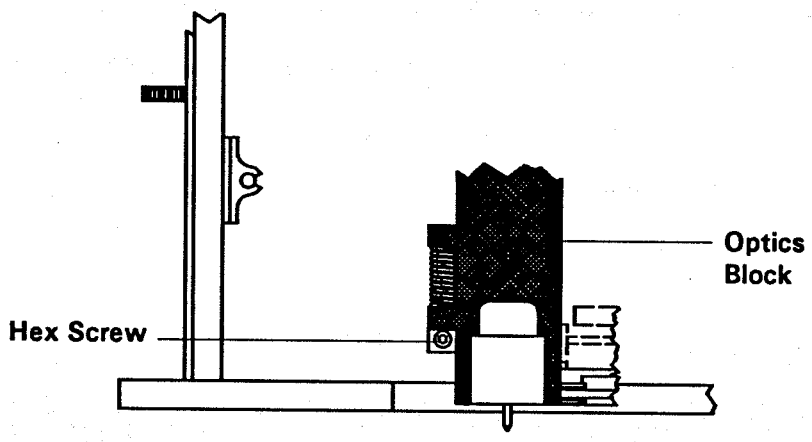


Figure 17-9 Focusing the Optics

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17.5 REPLACING THE FUSE

To replace the fuse:

1. Turn off the power to the instrument.
2. Locate the small black fuse box on the back of the instrument to the right of the power supply cord.
3. Unplug the cord from the instrument.
4. Pry off the fuse box cover with a small screw driver or similar tool. The fuse and an optional spare are attached to the inside of the cover.
5. Replace the fuse and the fuse box cover.
6. Plug the cord into the instrument.
7. Turn on power to the Tencor P-2.

17.6 MAKING A THETA DETENT REFERENCE ADJUSTMENT

The theta detent reference adjust is preset at the factory but you can fine tune it.

To make a theta detent reference adjustment:

1. Remove the side panel.
2. Loosen the clamping screw beneath the stage.

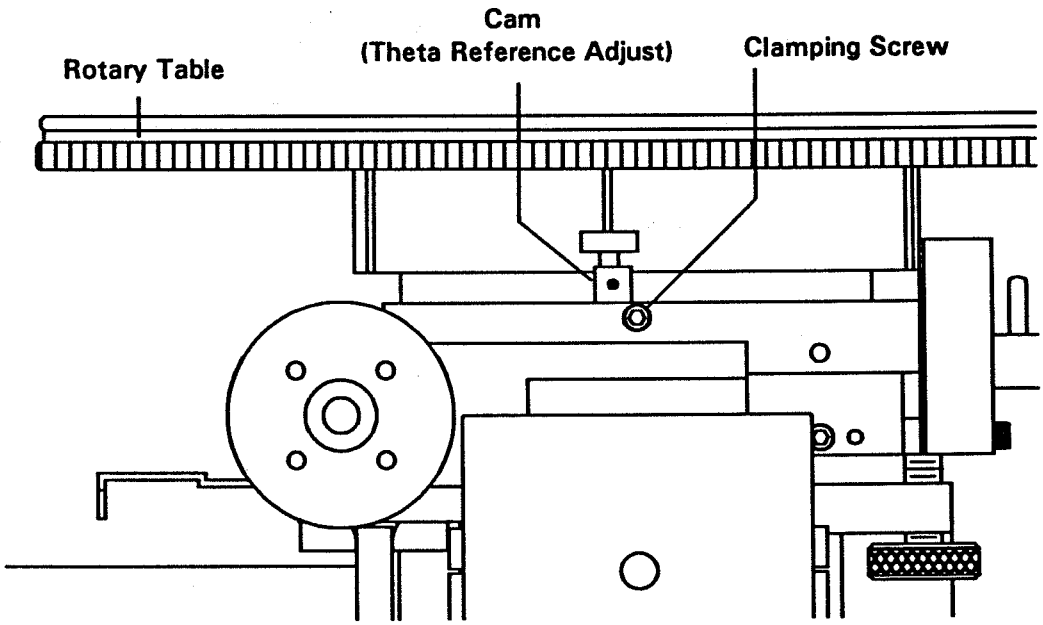


Figure 17-10 Making a Theta Reference Adjustment

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3. Insert a pin or small wrench into the cam adjust and turn the cam for fine theta adjustment. Theta can be adjusted 3 to 4°. If the reference is adjusted more than 4°, the detent force will be reduced.
4. Reinstall the side panel.

17.7 REPLACING THE SAMPLE ILLUMINATION BULB

> **NOTE:** **If you have the optional MicroHead instead of the standard measurement head, refer to Section 9.7, "Replacing the MicroHead Sample Illumination Bulb," for instructons on changing the bulb on a MicroHead.**

The illumination bulb for the optic lens is located in the back of the optics block (Fig. 17-9).

To replace the illumination bulb:

1. Raise the measurement area door.
2. Remove the left side panel. Each side panel is held by two thumb nuts on the inside upper corners. Support the left side panel from the outside and unscrew the thumb nuts. After removing the thumb nuts, gently lift the left side panel away from the instrument.
3. Lower the measurement head and null the stylus on a patterned substrate.
4. Raise the stylus. Loosen the 4 thumbscrews on the side of the measurement head cover and remove the head cover carefully.
5. Locate the wires for the illumination bulb at the back of the optics block.
6. Follow the wires to where they are plugged into a socket on the head electronics board. Mark the position of the socket and carefully unplug the wires.
6. Follow the wires to the optics block. The illumination bulb is held down by a bulb plate that has a Number 2 cap head screw.
7. Use a hex wrench (size 5/64 in.) to unscrew carefully the cap head screw on the bulb plate.
8. Remove the screw and bulb plate.
9. Pull the wires gently and the bulb should come out of the optics block.
10. Insert a new illumination bulb and replace the bulb plate and cap head screw. Try not to touch the bulb with your fingers.
11. Plug the wires of the bulb into the same socket in which the previous bulb wires were plugged. Look at the video image on the computer screen and make sure it is of acceptable quality.

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17.8 REMOVING AND INSTALLING THE HEAD ASSEMBLY

The modular design of the Tencor P-2 head assembly enables a user with no special mechanical aptitude or training to change the head using the following instructions. Important points to keep in mind while changing the head:

- Do not discard the special boxes and packaging used to ship the replacement head. Use the boxes and the packaging to return the damaged head to the factory. If the head is not shipped in the special protective boxes, Tencor Instruments will not be responsible for any damage to the head during shipment.
- Do not remove the stylus protection plate (Fig. 17-11) on the replacement head until you are instructed to do so.
- Follow the instructions in the same sequence as given below.
- The head weighs 10.5 lb and should be held with both hands when removed from or inserted into the instrument.
- If your instrument has the wafer handler installed, *do not* remove or replace the head from the handler side.

You will need the following to replace a damaged head:

- A 3/16-in. hex wrench
- 30 to 40 min. to remove and replace the head

17.8.1 REMOVING THE HEAD ASSEMBLY

We recommend that you read the following instructions a couple of times before beginning the removal procedure.

To remove the head assembly:

1. Raise the measurement area door.
2. Remove the side panels. Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument.
3. Install the stylus protection plate as follows (Fig. 17-11):
   - Raise the measurement head halfway up.
   - The red-colored stylus protection plate is stored on the storage screw on the left side of the measurement head. Unscrew the thumb nut holding the plate and remove the plate.
   - Hold the stylus protection plate with the guide pins facing up. Insert the guide pins into the holes on the left and right sides of the base plate below the stylus.

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- Screw the thumb nut on the screw above the base plate to hold the stylus protection plate in place.

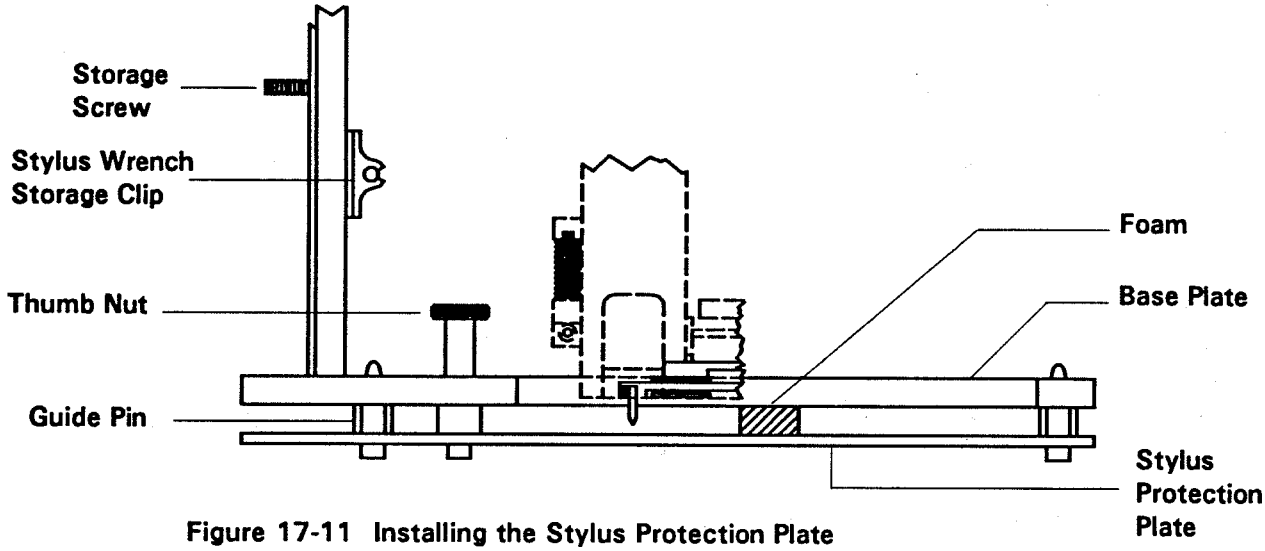


Figure 17-11 Installing the Stylus Protection Plate

4. Lower the measurement head until the rubber feet under the stylus protection plate are sitting on the stage table. Note that if the head is damaged, you might not be able to lower the head but you can still remove it.
5. Turn the power off and disconnect the flat cable connected to the head assembly on the right side (Fig. 17-12).
6. The head is attached to the elevator by four 1/4-20 screws, two on each side of the elevator (Fig. 17-12). These screws are accessible through the side panels. To free the head:
   - Use a 3/16-in. hex wrench to loosen all the four screws by a half-turn.
   - Do not remove the rear screw on the side from which you will lift the head out of the instrument. This screw will support the head until you are ready to lift the head out.
   - Remove the remaining three screws.

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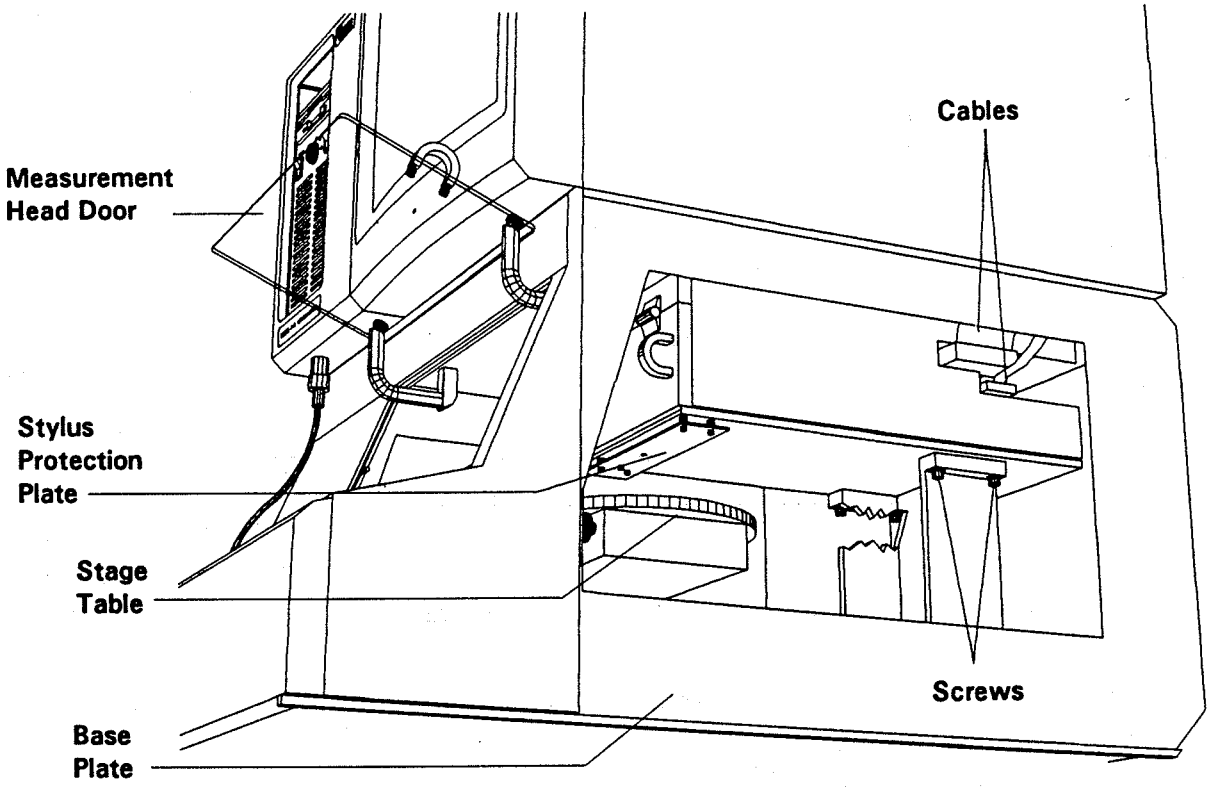


Figure 17-12 Removing the Head Assembly

7. When you are ready to lift the head out, place one hand below the base plate (Fig. 17-12) to support the head and remove the last rear screw.

> **CAUTION:** **When lifting the head, support the head with both hands, as it weighs 10.5 lb. Also, if your instrument has the wafer handler installed, *do not* remove the head from the handler side.**

8. Lift the head slightly at first to disengage the two locating pins that are used to position the head on the elevator. Then remove the head out of the side opening. Note: It is possible to remove the head from the front of the instrument but working from the side will give you more room.
9. Install the new head using the instructions in Section 17.8.2, "Installing the Head Assembly." Return the damaged head to the factory using the same boxes and packaging used to ship the replacement head.

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17.8.2 INSTALLING THE HEAD ASSEMBLY

We recommend that you read the following instructions a couple of times before beginning the installation procedure.

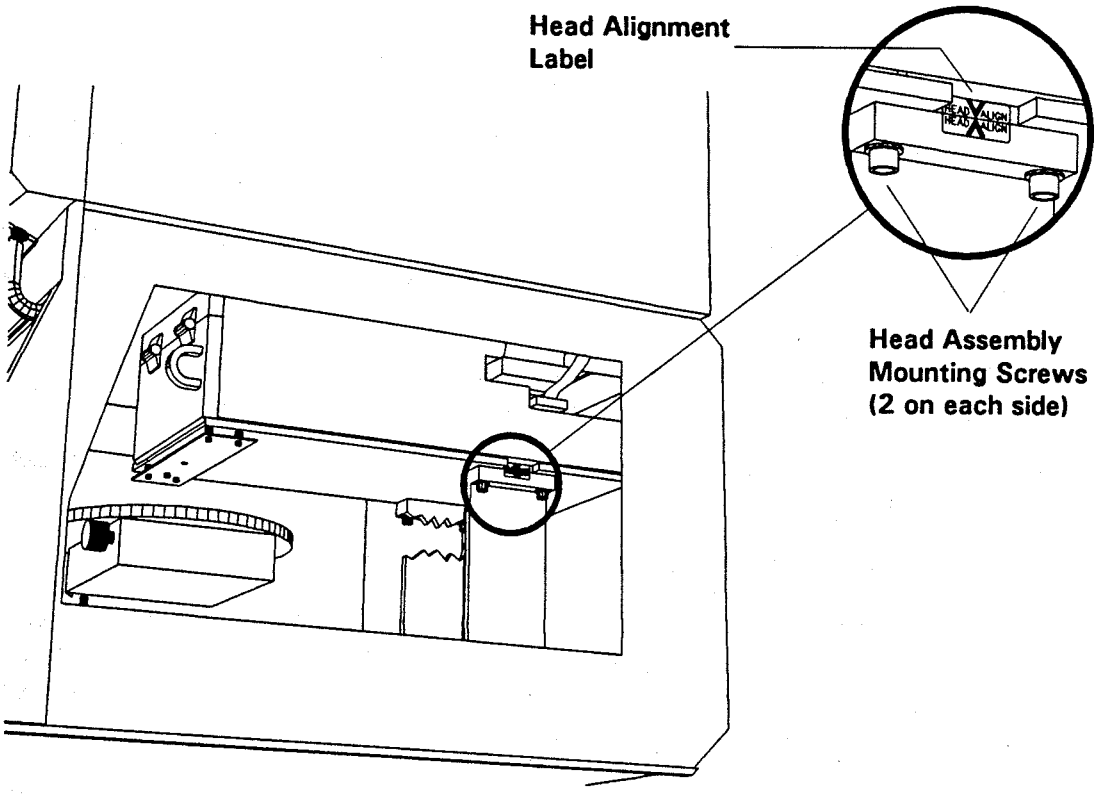


Figure 17-13 Installing the Replacement Head Assembly

To install the head assembly:

1. Unpack the replacement head carefully from its boxes and packaging.

> **NOTE:** **Do not throw away the special protective shipment boxes and packaging. The damaged head must be shipped in the same boxes and packaging used for the replacement head. If the head is not shipped in the special protective boxes, Tencor Instruments will not be responsible for any damage to the head during shipment.**

2. Raise the measurement area door.
3. Remove the side panels (if not already removed). Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument.

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4. Lift the head assembly by its base plate and carefully insert the head assembly into the front of the instrument and place it over the elevator.

> **CAUTION:** **When lifting the head, support the head with both hands, as it weighs 10.5 lb. Also, if your instrument has the wafer handler installed, *do not* insert the head from the handler side.**

   - The head assembly should fit snugly over two head assembly locating pins on the top of the elevator. See Fig. 17-13 for the location of the pins.
   - Use the head alignment labels, on either side of the head and elevator to guide the head assembly into its correct position. See Fig. 17-13 for the location of the labels.

5. Use a 3/16-in. hex wrench to replace the two 1/4-20 screws on each side on the elevator (Fig. 17-12). Tighten the screws to approximately 8 ft-lb.
6. Plug the two flat cables into the sockets on the right side of the head assembly (Fig. 17-13).
7. Remove the stylus protection plate (Fig. 17-11):
   - The stylus protection plate is a red-colored plate held below the stylus by a thumb nut on the top side of the measurement head base plate. Unscrew the thumb nut and gently apply downward pressure to both ends of the protection plate to remove it.
   - Do not store the stylus protection plate just yet. You will need the calibration numbers on the label on the back of the plate for setting up the measurement head software described in Section 17.8.3, "Setting Up the Measurement Head Software." Figure 17-14 is a sample calibration label.
8. Reinstall the side panels. Place each side panel against the instrument body, support the side panel from the outside, and screw on each thumb nut on the inner side. Each panel is held by two thumb nuts on the inner side.
9. Power up the instrument and set up the measurement head software using the instructions provided in the following section.

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17.8.3 SETTING UP THE MEASUREMENT HEAD SOFTWARE

You will need the calibration numbers provided on the label on the back of the stylus protection plate of the replacement head. Each head comes with its own set of calibration numbers.

> **NOTE:** This section applies to the standard measurement head. If you have the optional MicroHead installed, see Section 9.8, "MicroHead Setup and Diagnostics," for more information.

To set up the measurement head software:

1. Power up the instrument if not already powered up.
2. Choose Head Setup from the Calib menu and press ENTER to display the Measurement Head Setup window:

```
MEASUREMENT HEAD SETUP

Enter numbers from stylus protection plate.

 Stylus Force Calibration:
        0 mg                : 200
       10 mg                : 304
       40 mg                : 523
      100 mg                : 815
 Factory 300um Range Calc   : 0.9955
 Scan Length Calibration    : 0.0000000
 Reverse Backlash (um)      :   0
 Stylus Drop Timer[12-50]   :  23
 Linearity Calibration:
      'A' Coefficient       :  6315
      'B' Coefficient       : -2385

          F2:Save                    F4:Quit
```

Figure 17-14 Measurement Head Setup Window

All the numbers displayed in the Measurement Head Setup window belong to the damaged head.

3. Replace all the values with the values from the label on the back of the stylus protection plate. Press ENTER to return to the Calib menu. Figure 17-15 is a sample calibration label.

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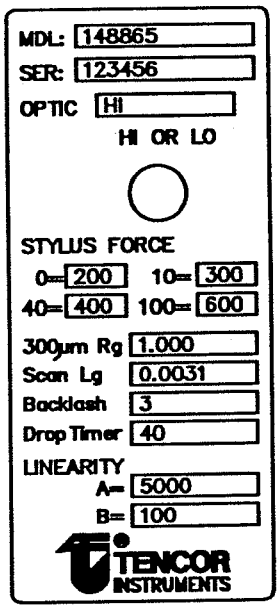


Figure 17-15 Sample Calibration Label

4. Choose Stylus Offset from the Calib menu and press ENTER to display the Stylus Force Offset window:

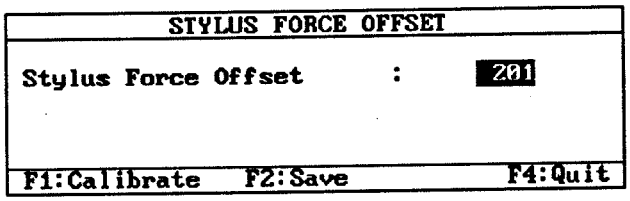


Figure 17-16 Stylus Force Offset Window

5. Press [F1: Calibrate] and then [F4: Quit] to exit the window.

NOTE: **The stylus force offset value computed must be 190 to 250. If not, adjust the stylus force offset using the procedure in Section 17.9.4, "Stylus Force Offset."**

6. Store the stylus protection plate:

   - The stylus protection plate is stored on the storage screw on the left side of the measurement head (Fig. 17-11). Keep the guide pins facing toward the measurement head, insert the middle hole of the protection plate into the storage screw, and screw on the thumb nut.

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17.8.4 SHIPPING THE DAMAGED HEAD

Return the damaged head to the factory. Pack the damaged head in the special protective boxes and packaging used to ship the replacement head. The shipping container displays the following label.

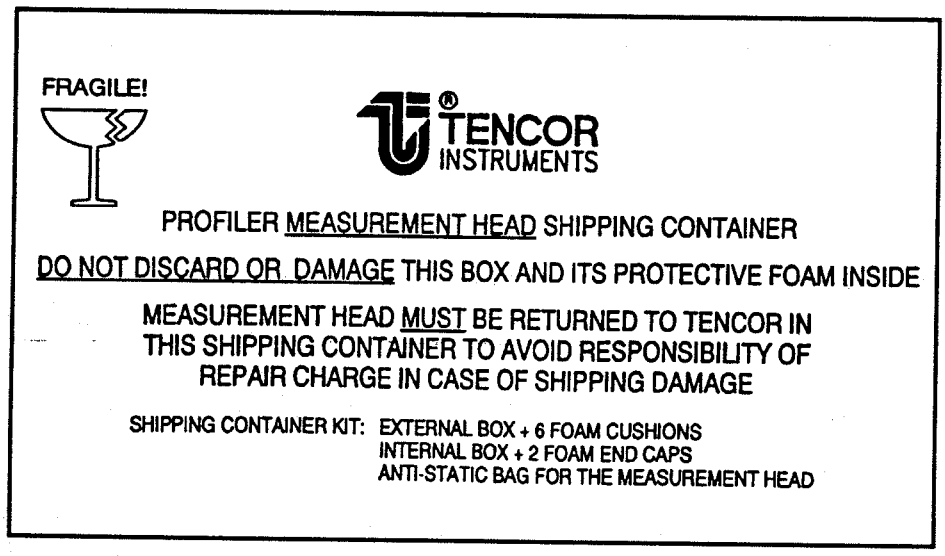


Figure 17-17 Measurement Head Shipping Label

> **CAUTION:** **If the head is not shipped in the special protective boxes, Tencor Instruments will not be responsible for any damage to the head during shipping.**

17.9 CALIBRATION

17.9.1 CALIBRATION FACTOR (Step Height Method)

The vertical sensing transducers in profilers are not absolute devices and, therefore, require calibration. The calibration factors for the two ranges are tuned to 1.00 at the factory. A software calibration technique, available to you from within the Tencor P-2 program, enables a ±5% correction from the keyboard for both the 13-μm and 300-μm ranges.

> **NOTE:** **You must calibrate *both* vertical ranges, and you must calibrate each range independently.**

The most precise calibration comes from precision techniques carefully repeated. To promote uniformity in results, the Recipe catalog provides special Scan recipes, named CALIB13 and CALIB300, for use in routine calibration of either range. The recipes are written for use with VLSI Standards Inc. step height calibration standards.

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Tencor Instruments does not have a recommended schedule for step-height calibration.

> **NOTE:** If you have the optional MicroHead installed instead of the standard measurement head, there are three vertical ranges to be calibrated (±3.5 μm, ±13 μm, and ±63 μm) with appropriate calibration recipes for each range; otherwise, the following instructions are the same.

To calculate a Calibration factor:

1. Press MENU.
2. Choose Catalog from the Recipe menu and press ENTER.
3. Choose the 13-μm recipe (CALIB13) or the 300-μm recipe (CALIB300) and press [F2: Recall]. Note that the recipe features ten repeat scans, delta averaging of the measurement point, and fixed spacing between measurement cursors.
4. Press [F4: Quit] to exit the recipe.
5. Load the step height calibration standard. Locate the stylus tip about 250 μm (one-fourth of the diameter of the stylus shank) from the calibration bar while in the Motion screen.
6. Press START to scan and wait for the ten scans to be repeated.
7. To call up the Calibration window, press MENU, choose Calib Factor from the Calib menu, and press ENTER.

```
CALIB FACTOR

Calibration Factor:
 6.5um/260uin Vert.Range :  1.0000
  26um/1.0mil            :  1.0000
 130um/5.2mil            :  1.0000

Multipoint Step Height:    Disable

Radius Calib Factor:        1.00000

F1:Calibrate   F2:Save                F4:Quit
```

Figure 17-18 Calibration Window

> **NOTE:** Make sure that the Multipoint Step Height field is set to Disable. See Section 17.9.3, "Multipoint Calibration," for more information.

8. Disable the Multipoint Step Height field (if enabled), then choose the appropriate calibration range and press [F1: Calibrate]:

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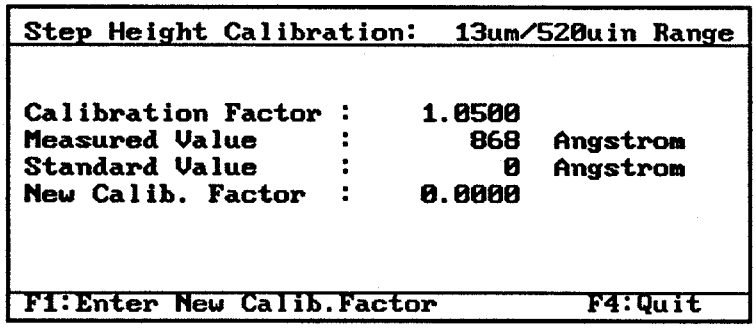


Figure 17-19 Step Height Calibration Window

Note that the value of the measurement just made appears in the Step Height Calibration window (Fig. 17-19) as Measured Value.

9. Choose Standard Value and use the keypad to enter the actual value of the standard specimen you just measured. Press ENTER to calculate and display the new Calibration factor. Note: You also can press [F1: Enter New Calib. Factor] after entering the standard value if you do not want to display the calculated value.

10. Press [F1: Enter New Calib Factor] to save and install the New Calibration factor displayed.

    Or, you also can enter the average of several different calibration factors resulting from the measurement of several step height standards. You can also offset the value by a predetermined factor to correlate with an existing database (see below).

To enter a known value:

1. Choose New Calib Factor in the Step Height Calibration window.
2. Type in the new value and press [F1: Enter New Calib. Factor]. Note: The Calibration factor is limited to the range between 0.95 to 1.05.

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17.9.2 RADIUS CALIBRATION

For highest-accuracy radius of curvature measurement with the Tencor P-2, the instrument should be calibrated with a high precision cylindrical standard whose radius is within a factor of 5 of the samples to be measured.

NOTE:	Read Section 7.6, "Radius Measurement," before performing this calibration.

To calibrate for radius measurements:

1. Press ESC.
2. Choose Catalog from the Recipe menu and press ENTER.
3. Choose the default recipe P2 (or any other suitable recipe) to use as a template. Edit the recipe as described in Section 7.6, "Radius Measurement." (The range of possible recipe settings is too great to include a prewritten recipe like the step height calibration recipes.)
4. Press [F1: Save] to save the recipe for future use, if desired.
5. Press [F4: Quit] to exit the recipe.
6. Load the radius calibration standard. In the Motion screen, locate the top of the arc and set the start-of-scan position as described in Section 7.6, "Radius Measurement."
7. Press START to scan and wait for the ten scans to be taken.
8. To call up the Calibration window (Fig. 17-18), press MENU, choose Calib Factor from the Calib menu, and press ENTER.
9. Press [↑] or [↓] to choose Radius Calib Factor from the Calib menu and press ENTER. The following window is displayed:

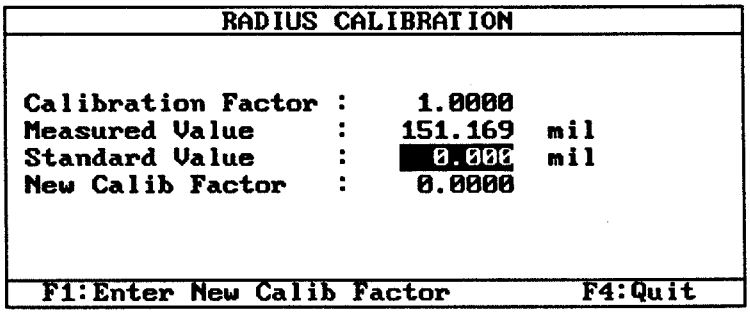


Figure 17-20 Radius Calibration Window

Note that the value of the measurement just made appears in the Radius Calibration window (Fig. 17-20) as Measured Value.

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9. Choose Standard Value and use the keypad to enter the actual value of the standard specimen you just measured. Press ENTER to calculate and display the new Calibration factor. Note: You also can press [F1: Enter New Calib. Factor] after entering the standard value if you do not want to display the calculated value.

10. Press [F1: Enter New Calib Factor] to save and install the New Calibration factor displayed.

Note that this calibration is only effective when radius measurement is enabled. This means also that the radius measurement should be disabled when the instrument is used for other types of measurements.

17.9.3 MULTIPOINT CALIBRATION

The Multipoint Calibration feature corrects step height values by interpolation of a multipoint (multilinear) calibration table rather than a single value. Without a multipoint calibration, measured values of a step height standard can differ from certified values when the step height standard is different than the one used for the single point calibration factor.

Assume, for example, that the instrument is calibrated using a standard with a *certified value* of 20,000Å and a *certified uncertainty* of 1%. When this standard is remeasured, the instrument will read 20,000Å accurately and repeatably.

Now, imagine a standard with a certified step height of 180Å and a certified uncertainty of 10% being analyzed with this calibration. The instrument will read a value (with a ±10Å repeatability) somewhere between 160Å and 200Å (about a ±10% window), not because the instrument is non-linear or working improperly but because there is uncertainty associated with the certified step heights.

Note that because the Tencor P-2 has linearity (better than 0.5%) and repeatability performance (better than 10Å) that are much smaller than the uncertainty of the standards (10% or worse for small step height standards), a multipoint calibration might *reduce*, not improve, the *accuracy* of a step height measurement. However, the multipoint calibration will enhance the *correlation* of measured values with certified values for a series of step height standards and make it easier to judge whether the instrument performs to expectations.

Note also that for standard values that are not included in the calibration table, the measured value obtained using multipoint calibration might still differ from the certified value, by as much as the certified uncertainty of the certified value.

To perform the multipoint calibration:

1. Press ESC/MENU to display the menu bar, if necessary.

2. Choose Calib Factor from the Calib menu. The Calib Factor window (Fig. 17-18) is displayed.

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3. Use [↑] or [↓] to select the Multipoint Step Height field. Press [←] or [→] to set this field to Disable.
4. Press [F1: Calibrate] to display the Multipoint Step Height Calibration window (Fig. 17-21). Press [F1: Clear] to clear the table of previous values.

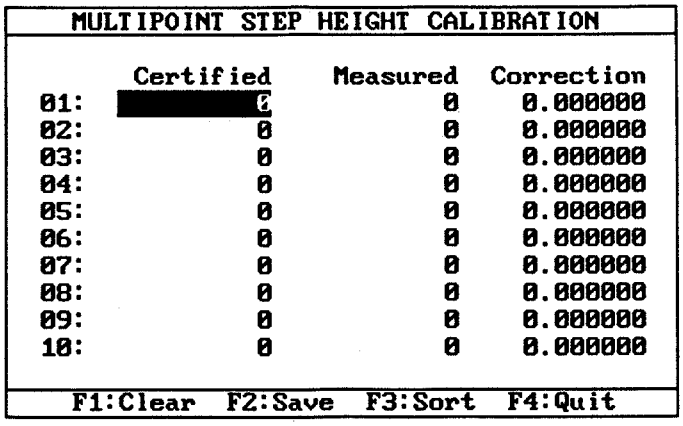


Figure 17-21 Multipoint Step Height Calibration Window

5. Press [F2: Save] to save the cleared table and return to the Calib Factor window.
6. For each range, perform the standard calibration described in Section 17.9.1 above, if it has not been done already.
7. Perform a step height measurement for each of the calibration standards to be used for the multipoint calibration. For each standard, write down the certified and measured step heights.
8. After the last measurement, press ESC/MENU to return to the menu bar, and again select Calib Factor from the Calib menu and press [F1: Calibrate].
9. Use [←], [→], [↑] and [↓] to move the cursor to each field and type the certified and measured step height values into the table. The software will calculate and display correction factors based on the entered values.
10. Press [F2: Save] to store the new table, then [F4: Quit] to return to the Calib Factor window. Enable the Multipoint Step Height field if desired, then press [F2: Save].

Raw data are stored after applying the standard, single-point calibration to each data point in the scan. Then, depending on whether the Multipoint Step Height Correction is enabled or disabled, the results that are displayed, printed, and stored in the summary data are affected as follows:

- With Multipoint Correction disabled, the Height parameter will always be the measured height based on the standard single-point correction factor.

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- With Multipoint correction enabled, the Height parameter will be calculated the conventional way and *then* corrected using the Multipoint Step Height Calibration table. No other parameters are affected.

Note that all surface parameters, including Height, are recalculated at the time when raw data is retrieved from the database. With Multipoint Step Height Correction enabled, the system uses the current calibration table. This means that if the Multipoint Step Height Calibration table has changed since the data were acquired and stored in the database, the Height parameter results might be slightly different. Also, old raw data can be recalculated using the current Multipoint Step Height Calibration table even if there was no such table when the data were acquired, or the previous calibration was in error.

17.9.4 STYLUS FORCE OFFSET

> **NOTE:** **This section applies to the standard measurement head. If you have the optional MicroHead installed, this calibration is performed automatically by the system. See Section 9.8, "MicroHead Setup and Diagnostics," for more information.**

The purpose of this calibration is to maintain accuracy of stylus force settings in spite of any mechanical changes in the stylus arm. Tencor Instruments does not have a recommended schedule for stylus force offset calibration but see the following note.

> **NOTE:** **Recalibrate the stylus force offset each time the stylus is changed, especially when operating below 10 mg.**

The stylus force is the force on the stylus tip when the stylus is in contact with the substrate. The stylus force offset is a reference number between 1 and 1000 indicating the force that the instrument applies to the stylus such that the stylus force is 0 at the null position. The stylus is at null position when it is midway between its highest and lowest limits, i.e., the stylus arm is horizontal and the readout is approximately 0.

If the stylus force is too high, the stylus might damage the substrate. If it is too low, the stylus will not drop down into a trough during a scan. A higher stylus force also provides greater noise immunity.

When performing this test, make sure the center vane of the sensor arm assembly is below the null position but not in contact with the lower sensor plate.

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To position the stylus:

1. Press ZΘ and [↓] to null the sensor on a smooth substrate.

> **NOTE:** The sample must be free of static charge as static charge can affect the stylus force calibration. To dissipate any static charge, clean the sample with liquid solvent.

2. Note the last three digits of the Z position readout.
3. Press [↑] to raise the measurement head a short distance, 50 to 100 μm.

To calibrate the stylus force offset:

1. Press MENU.
2. Choose Stylus Offset from the Calib menu and press ENTER.

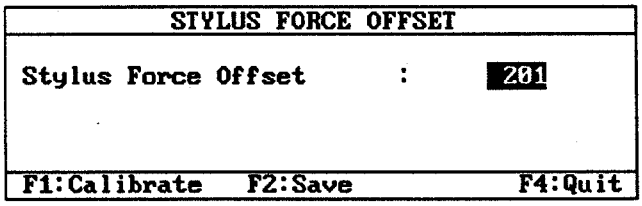


Figure 17-22 Stylus Force Offset Window

3. Press [F1: Calibrate]. The stylus force offset value is computed and displayed on the screen. The computation should take approximately 20 s.
4. Press [F2: Save] to enter the new offset.

> **NOTE:** The stylus force offset value computed must be 190 to 250. If not, adjust the stylus force offset using the following procedure.

5. Press [F4: Quit] to exit.

To adjust the stylus force offset:

1. Position the stylus (see "To position the stylus" above).
2 Raise the measurement head door and identify the stylus force offset screw (see Fig. 17-22) on the sensor assembly and insert a 0.05-in. hex wrench.

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CAUTION: Do not adjust screws other than the stylus force adjustment screw; otherwise, sensor linearity can be affected.

The Tencor Instruments Warranty Policy does not cover damage to the stylus assembly or the pivot caused by operator error or carelessness when changing the stylus.

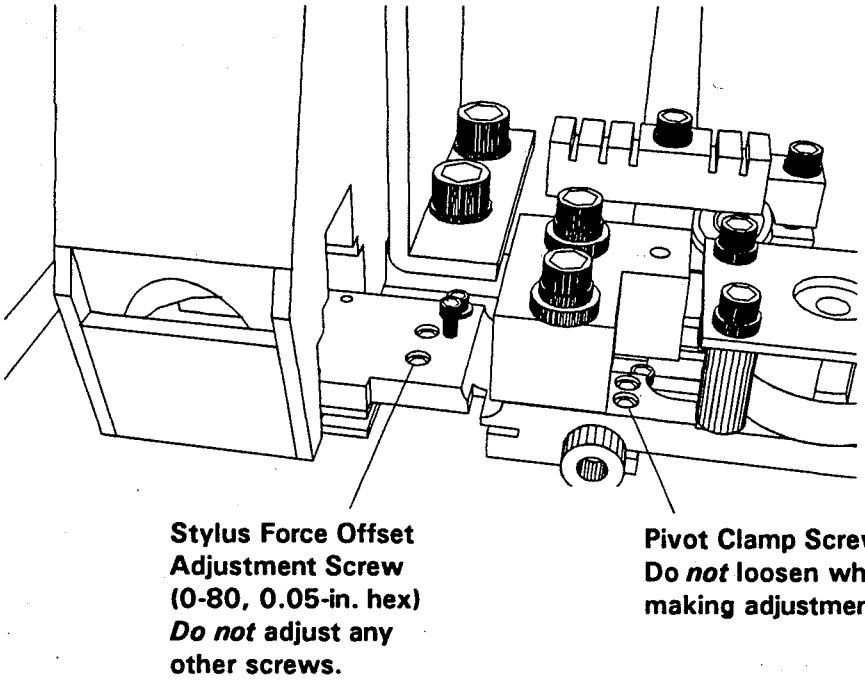


Figure 17-23 Adjusting the Stylus Force Offset

3. Turn the stylus force offset screw slightly; a 1/16th turn is recommended. Turn the screw counterclockwise to decrease the offset and clockwise to increase it.

CAUTION: A slight turn of the screw will induce a large change in the offset. Adjustments of 1/16th turn are recommended. Excessive adjustment of the offset screw can damage the stylus assembly.

4. Calibrate the stylus force offset value. See "To calibrate the stylus force offset" earlier in this section for details. If the optimal stylus force offset cannot be obtained without overadjusting the offset screw, contact Tencor Instruments Service for instructions. See Section 17.1.1, "Service Policy," for more information on contacting Tencor Instruments Service.

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17.9.5 SCAN POSITION OFFSET CALIBRATION

The Tencor Stylus Alignment Tool (Tencor Part No. 219517) is used to determine the distance that the stylus tip is offset from the cross hair overlay in the Motion screen in Slow and Precision modes (see Section 6.5, "Precision Mode"). When completed, you use the cross hairs to set coordinates for the beginning of the scan. The system takes care of positioning the stylus at the cross-hair location before the scan begins.

Perform the stylus offset calibration whenever you change the stylus. The following procedures assume that the stylus alignment tool (Fig. 17-24) is loaded into the instrument so that the alignment patterns are square to the stage X- and Y-axes.

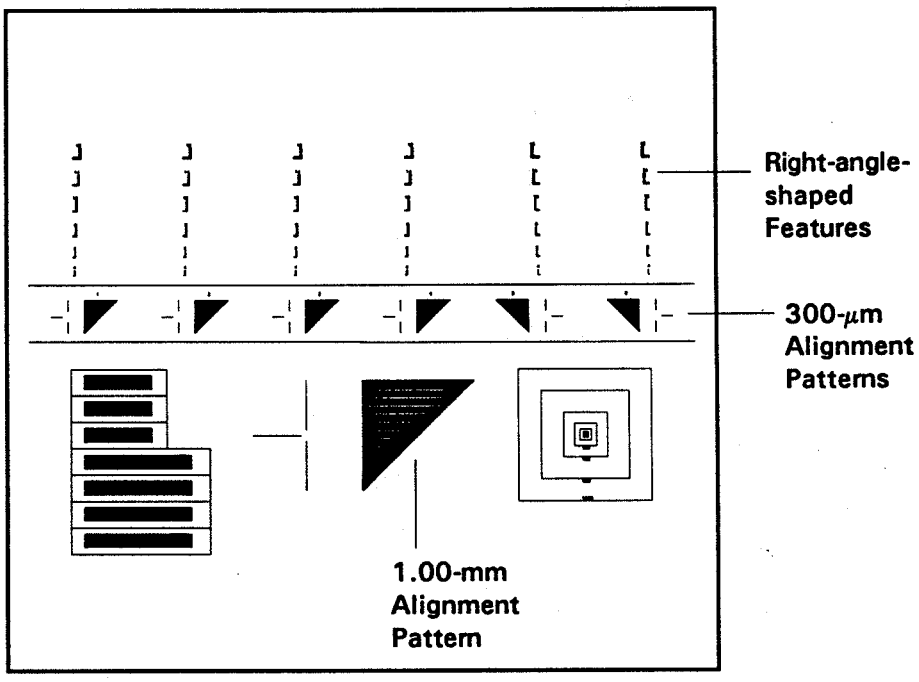


Figure 17-24 Tencor Stylus Alignment Tool

Before performing this calibration, set any pre-existing offset value to zero in the Stage Configuration window (Fig. 17-27) and set up Automatic Cursor Positioning as follows:

- Type to UpEdge
- Slope Threshold to 10
- Plateau/Apex Threshold to 10
- Minimum Plateau Width to some small value (less than 1 μm).

See Section 7.5, "Automatic Cursor Positioning (Edge Detection)."

To calibrate the Scan Position Offset:

1. Press MENU and choose Catalog from the Recipe menu.

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2. Select the recipe 150X150_CAL and press ENTER. The following recipe appears:

```
                              RECIPE
Recipe ID          : 150X150_CAL          Vertical Units     : Metric
Recipe Type        :    2D                V. Range/Res.      :    13um/1A
                                          Profile Type       :  ⎍
Horizontal Units   : Metric               V. Display Scale   :  Auto
Scan Length        :  500 um
Scan Speed         :    10 um/s
 Scan Time         :    50 sec
Sampling Rate      :   50 Hz              Graph              : Raw Data
 Horiz. Resol.     :  0.20 um             Long Wave Cutoff   : OFF
Direction          :  ->                  Short Wave Cutoff  : Default
                                          Fit & Level        :  Off
Multi-Scan Avg     :  1 [1-10]            Cursors: RELATIVE um     Left     Right
Segmented          :   No                  Measurement       :   -17.73    43.39
                                           Leveling          :  -137.73   213.93
                                           Delta Meas Width  :     0.00     0.00
Stylus Force       :  15.00 mg             Delta Level Width :    56.82    40.95
 Contact Speed     :  3
 Radius Required   :   0.0                Surface Parameters   View

          F1:Save     F2:Recall     F3:Cursors     F4:Quit
```

Figure 17-25 150X150_CAL Stylus Offset Calibration Recipe

3. Load the Stylus Alignment Tool in the instrument (see Section 6.3.1, "Loading a Sample Manually," for details).
4. Lower the measurement head until the sample surface is visible, then locate one of the 300-μm cross hair alignment patterns:

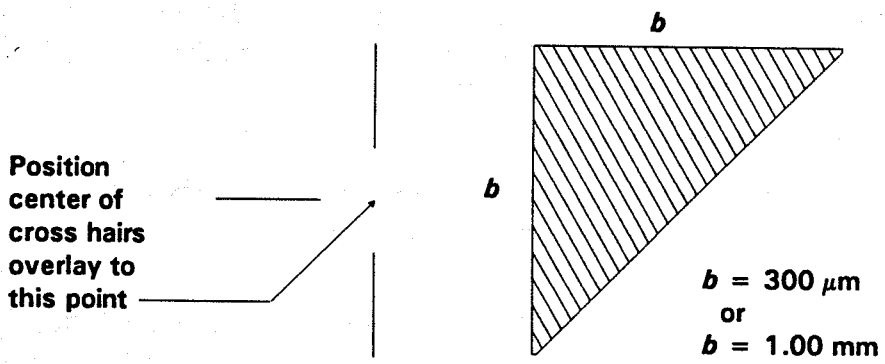


Figure 17-26 Cross Hair Alignment Pattern

X= 47
Y= 139

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> **NOTE:** There are two different-sized alignment patterns for the Scan Offset calibration on the Stylus Alignment Tool. See Fig. 17-24. Both are right triangles with two equal sides; one has 300-μm sides, the other 1.00-mm sides. There are six of the smaller patterns, and one of the larger.
> Use one of the 300-μm triangles first, scanning with the recipe 150X150_CAL. If the stylus offset is too great, the calibration scan will miss the triangle. In that case, try the 1.00-mm triangle first, with the recipe 500X500_CAL. After calibrating to the 1.00-mm triangle, repeat the 300-μm calibration.
> If the calibration scan misses the 1.00-mm triangle, the stylus needs to be physically realigned by an authorized Tencor Instruments service representative.

5. Make sure that the optical magnification is at the maximum setting (press ZOOM, then hold down [↑] until no further change occurs in the image). Then lower the measurement head until the stylus is nulled on the sample surface (press ZΘ, then [↓] until the Z coordinate remains unchanged). This assures that the camera is looking at the surface from the optimal position.

> **NOTE:** If precision alignment for sequence operation (features ≤10 μm) is required, the optical magnification *must* be at maximum zoom, and the stylus *must* be nulled as described, or the scan offset calibration will not be accurate. The same applies to setting locations in the sequence program.
> Also, if you want to scan right to left, perform the calibration with one of the two rightmost 300-mm patterns (see Fig. 17-24). Be sure to edit the 150X150_CAL recipe to scan from right to left.

6. Tap [↑] momentarily to lift the stylus without raising the measurement head.
7. Press XY and, if necessary, press [F1: Motion] until Precision mode is selected. Use the arrow keys (*not* the trackball) to line up the cross hairs to the pattern on the alignment tool as indicated in Fig. 17-26.
8. Press START. The instrument will scan the triangular feature to the right of the alignment pattern.

> **NOTE:** After the scan is taken, the cross hairs will not appear to return to the correct position. This is because the instrument backlash has not been shaken out yet; this happens at the start of the next scan.

9. When the scan is completed, press MENU, then choose Stage from the Config menu (Fig. 17-27). Press [↑] or [↓] to select the first Scan Position Offset field.

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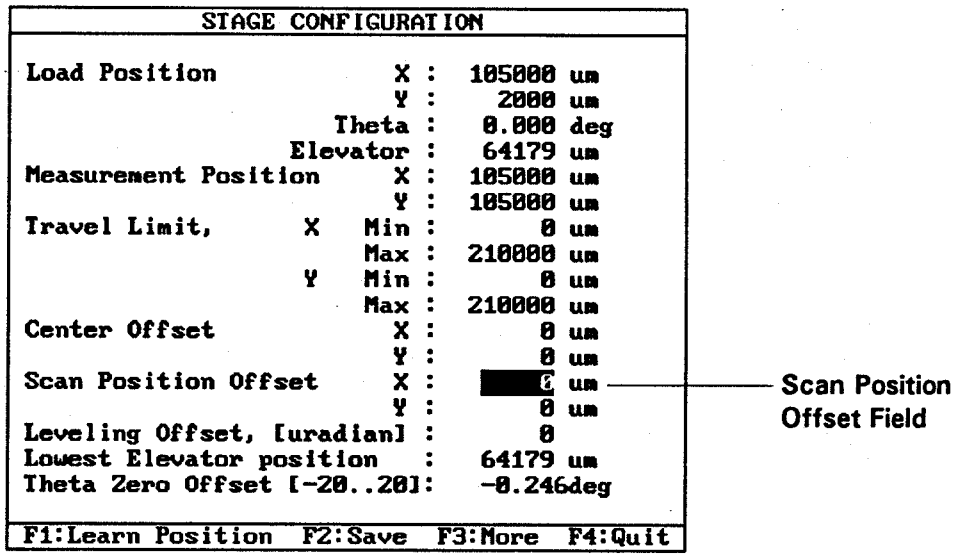


Figure 17-27 Stage Configuration Window

10. Press [F1: Learn Position]. The following window appears:

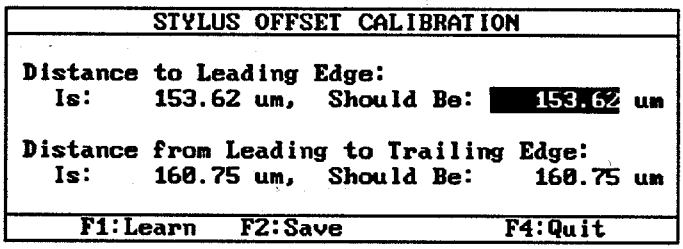


Figure 17-28 Stylus Offset Calibration Window

11. Use [↑] or [↓] to select the two fields on the right side labeled "Should Be" and type the value 150 (for the 300-μm triangle) or 500 (for the 1.00-mm triangle) into both X and Y fields.
12. Press [F2: Save]. The Stage Configuration window returns with calculated offset values entered in the Scan Position Offset fields (Fig. 17-29).
13. Press [F2: Save] to save the stage configuration settings.

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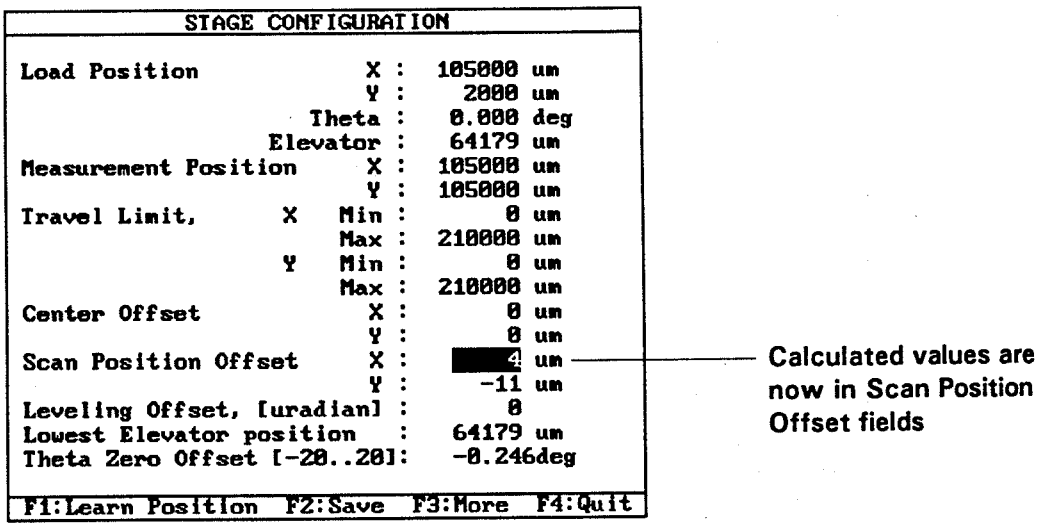


Figure 17-29 Stage Configuration Window After Position Learn

Note that it is difficult to verify the accuracy in the Y dimension. Therefore, it is a good idea to check your calibration before proceeding to scan samples. The Stylus Alignment Tool provides a set of right-angle-shaped features (Fig. 17-30) of varying dimension that are useful for checking the calibration. Use the feature that has dimensions on the order of the smallest features you intend to measure.

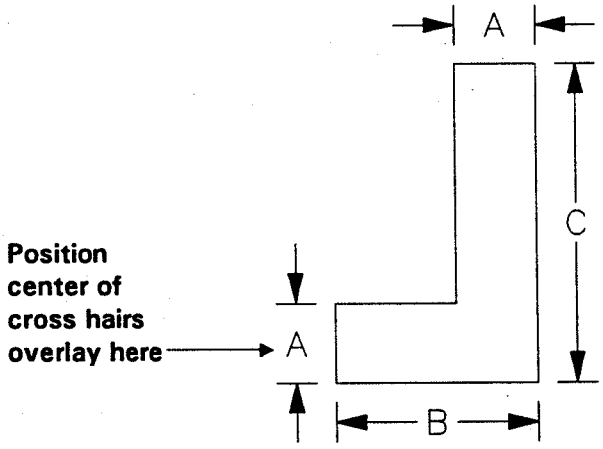


Figure 17-30 Right-angle-shaped Feature

To check the Scan Offset calibration:

1. Locate one of the right-angle-shaped features (Fig. 17-30) with the center of the cross hairs and perform a scan (see Table 17-2 for available dimensions). The scan length you choose should allow you to completely scan across the feature.

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2. If the stylus sets down above or below the bottom of the L, the calibration should be redone.

Table 17-2 Available Dimensions for Fig. 17-30

A (μm)	B (μm)	C (μm)
4	16	50
6	24	60
8	32	80
10	40	100
14	56	100
18	72	100

NOTE: **Once the calibration is done, be sure to use the cross hairs and not the stylus location to set scan positions.**

17.10 LUBRICATION

Your instrument might use either Tri-Flow lubricant (Tencor Part No. 069213) or Braycote lubricant (Tencor Part No. 177555) for lubricating the reference flat and lead screws. The proper lubricant to use on your instrument is specified on the labels affixed to each lubrication point. *Do not* use any other than the specified lubricant. Follow all the warnings on the Tri-Flow or Braycote bottle.

17.10.1 LUBRICATING X-, Y-AXIS LEADSCREWS AND REFERENCE FLAT

The X-, Y-, and Z-axis leadscrews have lubrication wicks to extend the service life and to allow long periods between preventive maintenance. Use Tri-Flow or Braycote only, as specified on the labels affixed to each lubrication point of your instrument.

To lubricate the X- and Y-axis leadscrews and the reference flat:

Lubricate the X- and Y-axis leadscrews and the reference flat every 12 months based on average use in a relatively clean environment.

1. Remove the left side panel. Each side panel is held by two thumb nuts on the inside upper corners. Support the side panel from the outside and unscrew the thumb nuts. After removing the thumb nuts, gently lift the side panel away from the instrument.

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> **NOTE:** Be very careful not to bump the stylus or the sensor assembly when lubricating the leadscrews or the reference flat. You might want to install the stylus protection plate for added protection of the stylus. See step 3 in Section 17.8.1, "Removing the Head Assembly," for details on installing the stylus protection plate.

2. Use a clean-room wipe to wipe off any excess lubricant or dirt that might have accumulated on the leadscrews. Move the stage around using the trackball to clean the entire length.
3. Put several drops of the lubricant on the leadscrews and move the stage around to distribute the lubricant and recharge the wick. Continue adding the lubricant and moving stage until about 10 drops of the lubricant have been added to each screw.
4. Take a fresh clean-room wipe and carefully wipe all lubricant and dirt from the reference glass flat. Move the stage back and forth to clean the entire surface, and also remove any dirt that might have collected on the feet.

> **NOTE:** Do not use solvent to clean the reference flat unless essential.

5. Add approximately 10 to 20 drops of lubricant to the flat and rub it into the flat using a clean, dry clean-room wipe. Wipe off any excess with a fresh clean-room wipe.

> **NOTE:** The lubricant must be evenly spread over the entire surface of the reference flat.

To lubricate the Z-axis leadscrews:

Lubricate the Z-axis leadscrews every 24 months based on average use in a relatively clean environment.

1. Remove the left side panel. Each side panel is held by two thumbwheel knobs on the inside upper corners. Support the side panel from the outside and unscrew the thumbwheel knobs, then gently lift the side panel away from the instrument.

> **NOTE:** You also can access the lubrication hole in the elevator post through the measurement area door. Be very careful not to bump the stylus or the sensor assembly if accessing the lubrication hole from the front of the instrument. You might want to install the stylus protection plate for added protection of the stylus. See step 3 in Section 17.8.1, "Removing the Head Assembly," for details on installing the stylus protection plate.

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2. Raise the elevator to the top. The Z-axis leadscrews are lubricated through the hole in the left side of the elevator post near the center of the post.
3. Add two drops of lubricant into the lubrication hole and move the elevator up and down. Repeat until 10 drops of lubricant are added.

17.10.2 MOTORIZED LEVEL AND ROTATION OPTION STAGE

Lubricate the Motorized Level and Rotation Option stage once every 24 months. Use Tri-Flow or Braycote only, as specified on the labels affixed to each lubrication point of your instrument.

LEVEL ADJUST LEADSCREW

1. Make a note of the level position so that you can return the stage to its original level position after lubrication. To note the level position:
   - Press XY to display the Motion screen.
   - Press LEVEL. Make a note of the Mechanical Level Angle displayed on the screen and exit the screen.
2. Press SEL and [↑] or [↓] to move the motor through its travel. Wipe any dirt on the leadscrew with a fresh, dry clean-room wipe.
3. Add two drops of lubricant to the level adjust screw and use [↑] or [↓] to move the motor through its travel so that the lubricant is spread evenly.
4. Return the table level motor to or near the original Mechanical Level Angle.

THETA ROTATION GEAR

The Theta Rotation gear can be lubricated with grease (Tencor Part Number 066702) or the lubricant (Tri-Flow or Braycote) specified on the labels affixed to each lubrication point of your instrument. If your instrument uses grease, lubricate the gear every 12 months; if your instrument uses Tri-Flow or Braycote, lubricate the gear every 24 months.

If grease is used:

1. Raise the elevator to the top.
2. Remove the table top:
   - Use a short slotted screwdriver or a 9/64 hex wrench to remove the three 8-32 screws.
   - Lift the table top away.

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> **CAUTION:** Be very careful not to bump the stylus or the sensor assembly when removing the table top. You might want to install the stylus protection plate for added protection of the stylus. See step 3 in Section 17.8.1, "Removing the Head Assembly," for details on installing the stylus protection plate.

3. Wipe off all grease from the Theta Rotation gear using a fresh clean-room wipe.
4. Apply a small dab of grease to the screw where the screw meets the worn gear.
5. Rotate the Theta Rotation gear: First press ZΘ, then hold down SEL and press [←] or [→]. Rotate the gear several times to evenly spread the grease.

If Tri-Flow or Braycote lubricant is used:

1. Remove the front sheet metal plate:
   - Loosen the two 4-40 screws holding the plate.
   - Lift the plate away.

> **CAUTION:** Be very careful not to bump the stylus or the sensor assembly when removing the table top. You might want to install the stylus protection plate for added protection of the stylus. See step 3 in Section 17.8.1, "Removing the Head Assembly," for details on installing the stylus protection plate.

2. Wipe off any dirt on the Theta Rotation gear using a fresh clean-room wipe. Rotate the Theta Rotation gear: First press ZΘ, then hold down SEL and press [←] or [→].
3. Remove the rechargeable wick. To reuse the wick, clean it using a clean-room wipe. You also can replace the wick if excessively dirty.
4. Add approximately 25 drops of lubricant to a new wick or add approximately 10 drops to the cleaned wick until evenly saturated without dripping.
5. Install the wick. Note: The wick should not drip when touching the theta gear.
6. Rotate the Theta Rotation gear to evenly spread the lubricant. Also, wipe up any drips.
7. Install the front sheet metal plate.

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17.10.3 MANUAL LEVEL STAGE

Lubricate the manual level stage every 24 months. Use Tri-Flow or Braycote only, as specified on the labels affixed to each lubrication point of your instrument.

To lubricate the manual level stage:

1. Raise the measurement area door.
2. Remove the right side panel. Each side panel is held by two thumb nuts on the inside upper corners. Support the side panel from the outside and unscrew the thumb nuts. After removing the thumb nuts, gently lift the side panel away from the instrument.
3. Use a clean, dry clean-room wipe to remove any dirt on the leveling leadscrew.
4. Add two drops of lubricant to the leveling leadscrew. Manually rotate the knob to work in the lubricant.
5. Return the table to a level position.

17.11 PRINTER AND KEYBOARD DIAGNOSTICS

The following diagnostic menus are provided in case of printer or keyboard problems. Both diagnostic windows are accessed from the Diag menu.

If your keyboard responds to keystrokes as if the key had been pressed twice or more, use the Printer Diagnostics window to try resetting the keyboard.

To access the Printer Diagnostics window:

1. Choose Keyboard from the Diag menu and press ENTER. The following window is displayed:

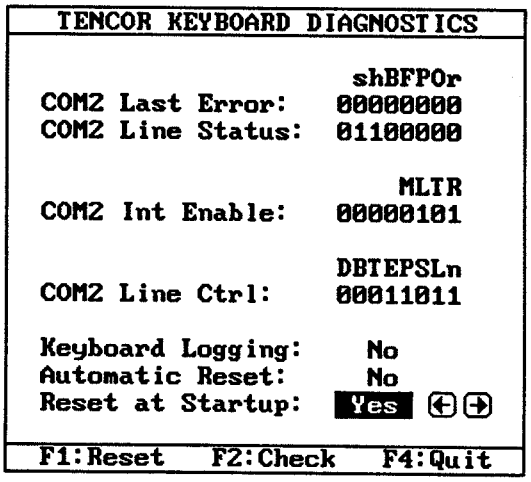


Figure 17-32 Keyboard Diagnostics Window

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2. Press [F1: Reset]. Then press [F4: Quit] and try the keyboard again. If the problem persists, repeat Steps 1 and 2.

To access the Printer Diagnostics Menu:

- Choose Printer from the Diag menu and press ENTER. The following window is displayed:

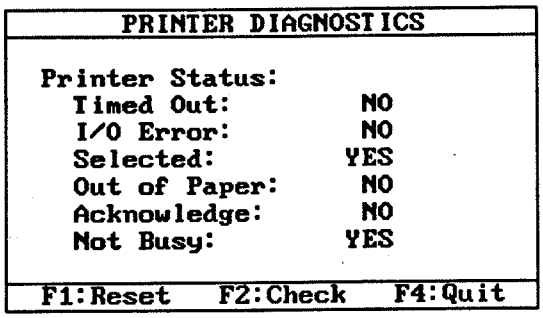


Figure 17-31 Printer Diagnostics Window

17.12 SHUTTING DOWN THE INSTRUMENT

The following procedure prepares the instrument for moving or shipping by automatically parking the disk to an unused cylinder. This procedure is recommended any time that the instrument is powered down to insure against loss of data and/or recipes.

To power down the Tencor P-2:

1. Choose Shutdown from the Exit menu.
2. Press ENTER.
3. When asked to confirm power down, press YES.
4. Turn off power to the instrument.

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18 SOFTWARE MAINTENANCE

This chapter is intended for users who have extensive experience using PCs in an MS-DOS environment. This material documents

- Procedures for checking available storage space on the computer's hard disk
- Batch programs to help you in managing your files; for example, backing up or retrieving files. You also can delete data from the database to provide more storage space, and you can copy recipes and Sequence programs to another instrument.
- Procedures to recover the database if you get error messages indicating database corruption
- Programs for troubleshooting database problems
- Procedures for formatting diskettes and restarting the program from DOS
- The required directory structure

18.1 CHECKING MEMORY AVAILABLE ON THE HARD DISK

> **CAUTION:** **Avoid overloading the hard disk. If you get a message such as "Insufficient space on drive" or "Out of disk space," your database can become corrupted. Periodically check the amount of space left on the hard drive. When the drive is more than 90% full, stop storing data and delete some files.**
>
> **If you have the SECS Communication Option, set Save to On and enable automatic uploading with the SECS Option (see Section 6.14, "Setting the SECS Interface Option to Upload Data"). The data will be saved to a host computer rather than to the hard disk.**

To check the memory available on the hard disk:

1. Press MENU.
2. Choose Disk Path from the Config menu to display the following window:

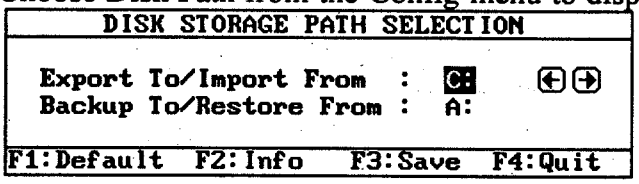


Figure 18-1 Disk Storage Path Selection Window

2. Press [F2: Info] to determine the amount of space available on the hard drive.

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18.2 USING BATCH UTILITY OPTIONS

> **NOTE:** Users with the Database Manager Option can use all batch utility options except the PURGEDB batch utility. We recommend that if you have the Database Manager Option, you should use the options provided within the Database Manager Option to manage your data.

This section describes batch programs available to help you manage your files.

All the following operations must be performed from the DOS prompt. Sometimes, you must go to a specific DOS directory to perform an operation; in such cases, directions to do so are provided. If you are in the main program, exit to DOS as follows.

> **NOTE:** The keylock must be in position 3 to exit to DOS.

To exit to DOS:

1. From the main menu bar, choose To DOS from the Exit menu.
2. Press ENTER.
3. Type Y when asked to confirm that you wish to return to DOS. The DOS prompt will show that the current directory is C:\TENCOR. Note: To reenter the program from DOS, you must be in the C:\TENCOR directory.

18.2.1 BACKING UP FILES

> **NOTE:** If you have the Database Manager Option, you should use the options provided within the Database Manager Option to back up your data. See Section 12.4.4, "Backing up Data," for more information.

Use the DOS BACKUP command to back up database files periodically.

All files other than database files are normally duplicated on the Tencor P-2 installation diskettes; therefore, backup is not as critical for these files. The Tencor P-2 installation diskettes contain all the application programs and data.

Before starting a backup, check that you have an adequate number of diskettes to store all the files to be backed up.

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> **NOTE:** The backup process deletes all files on the root directory of the backup diskettes. Note also that you need to record the order in which diskettes are used in the backup operation because the diskettes must be used in the same order when the files are restored. In case the diskette numbers are not recorded, see Section 18.2.6, "Database Recovery," for procedures on displaying the diskette sequence numbers.

A batch program is supplied for backing up only the active database files. You can use this batch file from any directory.

To back up active database files:

At the DOS prompt, type *backupdb* and press ENTER.

To back up other files:

To back up other files such as the export files created by the main program, you must use the DOS BACKUP command. Two examples are given below:

- To back up export files:

  At the DOS prompt, type *backup c:\tencor\exp* prn a:/f* and press ENTER.

- To back up all files from the hard disk to diskettes, enter one of the following commands.

  If the diskette is formatted, at the DOS prompt type *backup c:*.* a:/s* and press ENTER.

  If the diskette is unformatted, at the DOS prompt type *backup c:*.* a:/s/f* and press ENTER.

Note: You will need approximately 28 1.44-MB diskettes to back up an entire 40-MB hard disk (84 to back up a 120-MB hard disk). For more information refer to the *Microsoft DOS Version 5.0 Reference Manual.*

18.2.2 RESTORING FILES

> **CAUTION:** Avoid overloading the hard disk. See Section 18.1, "Checking Memory Available on the Hard Disk."

Use the DOS RESTORE command to restore database files backed up using the DOS backup utility. The batch program BACKUPDB is recommended for storing the active database files. A batch program is provided to restore database files you saved using the BACKUPDB program.

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> **CAUTION:** Restoration will overwrite any current files with the same name as those being restored. For this reason, it is recommended that users with the Database Manager Option use the Backup/Restore options provided under the Data/Maintenance menu. See Section 12.4, "Maintaining the Database," for more information.

To restore files saved with BACKUPDB:

At the DOS prompt, type *restordb* and press ENTER.

To restore other files:

To restore other files such as the export files backed up in the previous section's example, use the DOS RESTORE command.

At the DOS prompt, type *restore a: c: \tencor\exp* and press ENTER.

> **NOTE:** You must insert the diskettes in the same order as they were used in the backup procedure. If the diskette numbers are not recorded, see Section 18.2.6, "Database Recovery," for procedures on displaying the diskette numbers.

18.2.3 ERASING A FILE

To erase a file:

To erase (delete) a file, use either the DOS ERASE command or the DOS DEL command. For example, to erase an exported data file:

At the DOS prompt, type *erase c:\tencor\exp\mydata.prn* and press ENTER.

To erase all exported data files:

To erase all the exported data files while in the C:\TENCOR directory:

At the DOS prompt, type *erase exp*.prn* and press ENTER.

Use caution when erasing files because it is easy to delete an entire directory accidentally. For this reason, the active database files are write-protected.

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18.2.4 REMOVING DATA FROM A DATABASE

> **NOTE:** If you have the Database Manager Option, do not use the PURGEDB batch program. Instead you should use the options provided within the Database Manager Option to delete data from the database. See Section 12.3.5, "Deleting Data," and Section 12.4.2, "Purging Data," for more information.

When your hard disk is full and you need more space, you can delete data from the database. One method is to use the Delete function in the Data catalog, but this method is very slow. The batch utility, PURGEDB, removes all the data from the database while retaining the Scan recipes and Sequence programs.

The PURGEDB batch program can be used to delete data saved in software versions 1.1 and later *without* the Database Manager Option. Use the delete function in the Data catalog to delete data saved under software version 1.3 and later. You cannot use the Delete function to delete data saved under previous software versions.

> **CAUTION:** Use PURGEDB only when you want to remove *all* data from the database.

To delete all the data from the database:

1. From the menu bar, choose Exit/To DOS and press ENTER.
2. At the DOS prompt, type *purgedb* and press ENTER.

   The program can take a long time to run, depending on the amount and type of data in the database, but this method is faster than the Delete function in the Data catalog and requires no operator intervention.

18.2.5 COPYING FILES TO ANOTHER INSTRUMENT (DATABASE MANAGER OPTION ONLY)

You can copy Scan recipes and Sequence programs from one instrument to another without copying the data as well.

> **NOTE:** Copying Scan recipes and Sequence programs to another instrument overwrites the database on the destination instrument. Use the utilities provided within the Database Manager Option to transfer Scan recipes and Sequence programs without overwriting the database on the destination instrument.

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To copy Scan recipes and Sequence programs to another instrument:

1. Back up the entire database from the source instrument onto diskettes using the BACKUPDB batch utility (see Section 18.2.1, "Backing Up Files").
2. Restore the entire database to the destination instrument, using the RESTORDB batch utility (see Section 18.2.2, "Restoring Files").
3. Run the PURGEDB utility on the destination instrument to remove all data from the database (see Section 18.2.4, "Removing Data from a Database"). Scan recipes and Sequence programs will be retained.

18.2.6 DATABASE RECOVERY

These recovery procedures apply to users with and without the Database Manager Option. You must use these procedures to recover your database if you have received an error message that indicates a corruption in the database.

To set up the backup diskettes for database recovery:

1. Exit to DOS if you have not already done so.
2. Find the complete set of your most recent database backup diskettes. These should have been numbered sequentially (a full set will usually have space left on the last diskette).
3. If the diskettes are not numbered sequentially, do the following to find out the order of the diskettes. Put each diskette into the drive and type *dir a:* and press ENTER. Check the extension of the file or files. The extension will list the backup sequence number, for example, 001 for the first diskette, 002 for the second diskette, and so forth.
4. Use the following procedure to check if the backup is a DOS backup or a backup done internally:
   - Insert a backup diskette into the drive and type *dir a:* and press ENTER.
   - If the following filename appears, the backup is an internal backup:

     P2DBBAK.*nnn* (where *nnn* is a digit from 0 to 9)
   - If either of the following filenames appear, the backup is a DOS backup:

     BACKUP.*nnn* (where *nnn* is a digit from 0 to 9)

     CONTROL.*nnn* (where *nnn* is a digit from 0 to 9)

If the Database Manager Option is installed, you might be able to save much of the data that has been collected since the last backup.

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To back up data that has been collected since the last backup:

1. Get a set of blank, formatted diskettes.
2. Restart the Tencor P-2 program (Section 18.3.2, "Restarting the Main Program") and use the internal backup procedures (Section 12.4.4, "Backing Up Data") to back up the data collected since the last backup.
3. Specify a Begin Time that is just before the time of your last *good*, complete backup. This will save you time and space.

To delete the corrupted database if the backup was an internal instrument backup:

1. At the DOS prompt, type *deletedb* and press ENTER.
2. Restart the Tencor P-2 program (see Section 18.3.2, "Restarting the Main Program").
3. Restore the database from the backup diskettes (not the diskettes made in the step "To back up data that has been collected since the last backup" above). See Section 12.4.5, "Restoring Data," for details on restoring data. When prompted, restore the entire database to make sure that you get all the Scan recipes and Sequence programs.
4. Check the available disk space, and then purge data that need not be kept online. Check the Recipe and Sequence catalogs and delete any data not needed.
5. If you backed up the most recent data collected after the last backup, restore this backed up data using the internal restoration procedure. (See Section 12.4.5, "Restoring Data.")

To delete the corrupted database if the backup was a DOS backup:

1. At the DOS prompt, type *restordb* and press ENTER. This DOS RESTORE program will instruct you when to insert a particular backup diskette.

> **NOTE:** **If the RESTORE program stops before it is done restoring, ends with an error message, or if you stop the RESTORE program by pressing RESET or CTRL + C, the restored database will be corrupted and unusable.**

2. Restart the Tencor P-2 program (see Section 18.3.2, "Restarting the Main Program") and check the catalogs to make sure that your old database has been restored. Purge any data, Scan recipes, and Sequence programs that are no longer needed online.

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18.2.7 TROUBLESHOOTING DATABASE PROBLEMS

Use the following programs under guidance from Tencor Instruments to troubleshoot database problems.

Table 18-1 Troubleshooting Files

Filename	Description
CHECKDB.BAT	Runs consistency checks on the Tencor P-2 database and generates a report in the file CHECKDB.OUT. Use the report to check the database and to help Tencor software engineers diagnose problems. Uses DBCHECK.EXE (see below).
FIXDBKEY.BAT	Rebuilds the database key files; use after a database check reports bad key files or key linkages.
CHAINDB.BAT	Runs the DCHAIN program (see below).
DUMPDB.BAT	Dumps the contents of the data and key files to the file DUMPDB.OUT; use to verify contents of the database.
PRDBD.EXE	Outputs the database definition file in readable form.
DATDUMP.EXE	Outputs the contents of data files in readable form.
KEYBUILD.EXE	Builds key files from data files.
KEYDUMP.EXE	Outputs key file contents in readable form.
DBCHECK.EXE	Checks database for consistency (see CHECKDB.BAT above).
DCHAIN.EXE	Sorts chain of deleted records for more efficient storage (see CHAINDB.BAT above).
OPENDB.BAT	Disables write-protection of database files; use before any of the .EXE programs listed above.
CLOSEDB.BAT	Enables write-protection of database files; use after any of the .EXE programs listed above.
DBRDONLY.EXE	Enables or disables write-protection on database files; used by each file above and by BACKUPDB.BAT, RESTORDB.BAT, and DELETEDB.BAT.

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To run a database maintenance batch program:

1. To run one of the batch programs listed above, you must be in the C:\TENCOR directory. To go to the correct directory, type *cd c:\tencor* and press ENTER. The prompt will read C:\TENCOR.
2. Type the filename without the .BAT extension and press ENTER. Each program invokes the database utility programs required to perform its task. The length of time required to run each program varies with the size of the database. When the program is complete, a message appears and the DOS prompt is displayed.

18.3 USING SUPPORT PROGRAMS

18.3.1 FORMATTING DISKETTES

Use the DOS command for formatting diskettes cautiously, because it is possible to reformat the hard disk (drive C) accidentally. This DOS command is also inconvenient to use, since it requires the use of switches and flags to format diskettes at different densities. To avoid these problems, two batch programs are provided to format diskettes for the saving and transferring of data.

To format a high-density (1.44-MB) diskette:

1. Insert the diskette to be formatted.
2. Type *format-h* and press ENTER.

To format a double-density (720-KB) diskette:

1. Insert the diskette to be formatted.
2. Type *format-d* and press ENTER.

The DOS FORMAT command will then prompt for the necessary input.

These two commands will each take up to two arguments from those available to the DOS FORMAT command. Refer to the *Microsoft DOS Version 5.0 Reference Manual* for more information, but note that the command options specifying diskette density are part of the above batch programs and should not be used with them.

18.3.2 RESTARTING THE MAIN PROGRAM

To start the main program from DOS, you must be in the C:\TENCOR directory. Although you can start the main program from another directory, the program will not be able to find its system files and will terminate.

To restart the main program:

1. To go to the correct directory, type *cd c:\tencor* and press ENTER. The prompt will read C:\TENCOR.

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2. To restart the main program, type *p2* (or *p2h* if your instrument is equipped with a handler) and press ENTER.

18.4 USING THE INSTALL #1 DISKETTE AS A BOOT DISKETTE

On instruments with an EGA video display, the monitor screen will remain blank until the Tencor IO/Video card is initialized. This requires one of several special programs to be run during the startup process, and can make troubleshooting instrument problems (especially hard-disk problems) difficult. In prior versions, provision was made for the creation of a special BOOT diskette. In version 1.5, the INSTALL #1 (System and Utilities) diskette was made bootable, with IO/Video card initialization included in the startup process.

To use the INSTALL #1 diskette as a boot diskette:

1. Insert the INSTALL #1 (System and Utilities) diskette.
2. Press RESET.
3. Answer 'No' (type *n* and press ENTER) when the instrument asks whether to install the Profiler software. The instrument will display a DOS prompt, at which time computer diagnostics and so forth can be run.

18.5 HARD DISK REPLACEMENT OR REPARTITIONING

It may become necessary to repartition and reformat the instrument's hard disk. There are at least two reasons for doing so:

- If the hard disk malfunctions and must be replaced
- If a larger main partition (C:) is necessary

In order to perform this procedure, a bootable MS-DOS 5.0 diskette containing the following files is required:

- FDISK.EXE
- FORMAT.COM
- SYS.COM
- Tencor-supplied CONFIG.SYS and AUTOEXEC.BAT files (and EGA.EXE, on instruments with an EGA video display).

CAUTION:	**Repartitioning will destroy any data and programs on the hard disk, so a backup is required if anything on the hard disk must be retained.**

On instruments with an EGA video display, the MS-DOS 5.0 release diskettes are not completely adequate for the repartitioning task. In the case of DOS upgrades, the DOS

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setup diskette is not bootable. The new-computer DOS setup diskette is bootable, but does not contain the Tencor files necessary to turn on the video display. To solve this problem, the INSTALL #1 (System & Utilities) diskette contains the necessary files. Should this be misplaced, Tencor service engineers will normally carry a support diskette containing the necessary files.

To partition and format either a new or an existing hard disk, perform the following procedure. Be sure to have all necessary diskettes on hand and any necessary backup made before beginning the procedure. Also be sure to understand the operation of the MS-DOS FDISK, FORMAT, and SYS programs before beginning the procedure.

To partition and format either a new or an existing hard disk:

1. Insert the INSTALL #1 or Service Support diskette and press the RESET button.
2. If asked if you wish to install the profiler software, type *n* for No and press ENTER. The installation will be performed later.
3. Type *fdisk*, then press ENTER.
4. In FDISK, delete any existing partitions.
5. Create a maximum-size, bootable, active partition; this will become drive C.
6. Exit FDISK; the system will reboot automatically.
7. When the DOS prompt reappears, type *format c:*, then press ENTER.
8. When formatting is complete, type *sys c:*, then press ENTER.
9. When system transfer has been completed, press the RESET button.
10. After the DOS prompt appears, perform the MS-DOS 5.0 installation. If the MS-DOS is an Upgrade copy, be sure to have a blank diskette on hand for use by the DOS Setup program; this is necessary even if no prior copy of DOS is present so that DOS Setup can create a boot diskette.
11. After DOS installation, install the Profiler software using the installation steps described in "Basic Installation Procedure" in Appendix B, "Installing Upgraded Tencor P-2 Software."

18.6 CONFIGURATION FOR NETWORK DRIVERS

The QEMM-386 memory manager has been preconfigured to generate the maximum possible RAM memory for the profiler application program and required utilities such as device drivers. Customers wishing to install network drivers should use the QEMM Manifest program (type *mft* and then press ENTER) after exiting the instrument main program to assist in loading the driver programs in the best possible way. Do not use the QEMM Optimize program because it is known to crash with the already highly-optimized memory allocation and complex batch-file structure used in Tencor Profilers. The load and run sizes of network driver programs will likely be known by the network administrator

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at your site. If necessary, the load and run sizes of the network driver programs can be obtained by using QEMM Optimize on another computer.

Customers with network drivers already optimized under 386MAX might gain some useful information on the memory sizes of their drivers for use under QEMM, but the QEMM and 386MAX memory size parameters are not necessarily equivalent. QEMM and 386MAX option flags, memory regions, and support programs are not compatible, so customers changing to QEMM should be sure to modify 386MAX parameters to their QEMM equivalents. Alternatively, if you are successfully using 386MAX and do not wish to change, you might find it possible to continue using 386MAX. To do so, the QEMM-specific load commands in the Tencor-furnished startup programs must be changed to their 386MAX equivalents.

Whenever optimizing load configurations using any memory manager, all the drivers and resident programs must be invoked in either CONFIG.SYS or AUTOEXEC.BAT (as appropriate), and the main Profiler program invocation should be temporarily removed from the AUTOEXEC.BAT calling sequence. This will require a text editor (EDIT.COM is easy to use) and some knowledge of how DOS uses CONFIG.SYS and batch programs. Some program orderings cannot be changed: in particular, the PrintCache and printer driver ordering pre-configured by Tencor Instruments is specific to the printer driver and cannot be changed.

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18.7 TENCOR P-2 DIRECTORIES

This section describes the Tencor P-2 directories and their contents. This material is useful when you are trying to debug a software problem and need to verify that all the required files are present on your instrument.

The required directory structure of the Tencor P-2 is displayed in Fig. 18-2.

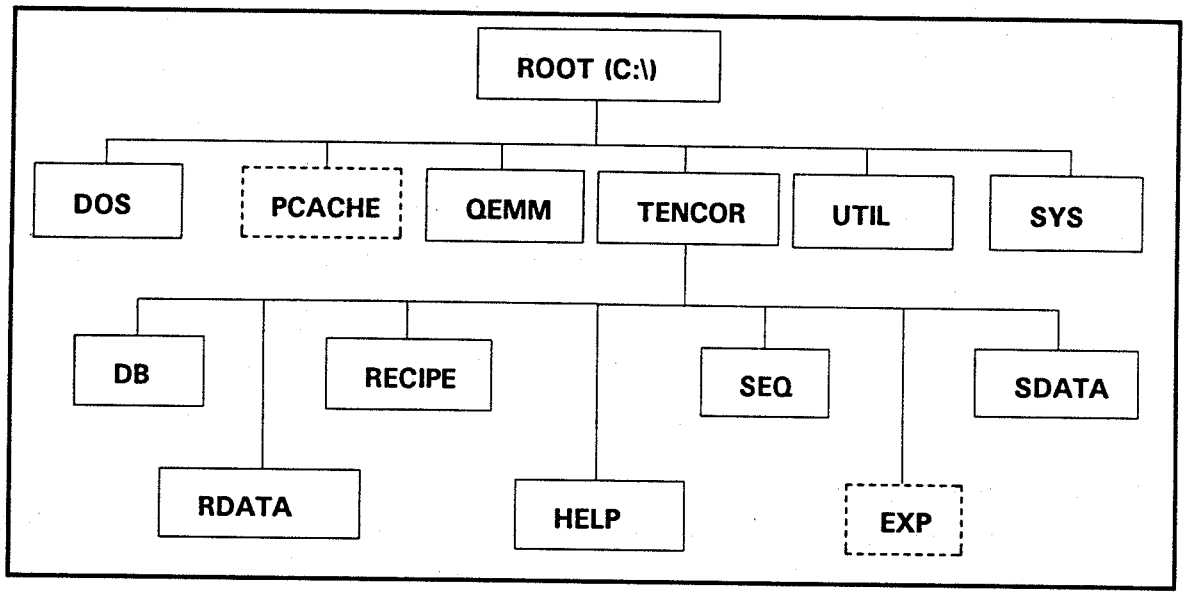


Figure 18-2 Tencor P-2 Directory Structure

NOTE:	Do not change any file even though some are readable (in ASCII format)—you will affect operation of the instrument. You can change only export files (see EXP directory) that are user files.

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18.7.1 ROOT DIRECTORY

The root directory must contain the files listed in Table 18-2.

Table 18-2 ROOT Directory Files

Filename	Description
AUTOEXEC.BAT	Main start-up program (ASCII)
CONFIG.SYS	System configuration file (ASCII)
COMMAND.COM	DOS command line interpreter
~PCACHE	PrintCache buffer (optional)
EMMSETS.BAT	Start-up subprogram to set memory manager
PRODSETS.BAT	Start-up subprogram to set product name
RUN.BAT	Start-up subprogram to invoke instrument main program
WINA20.386	MS-DOS 5.0 driver used for access to memory above 1 MB

18.7.2 DOS DIRECTORY

The DOS directory contains the files present on the IBM PC-DOS version 5.0 diskettes. Normally, the Tencor P-2 is set up to contain all DOS programs and system files.

18.7.3 PCACHE DIRECTORY

The PCACHE directory contains the PrintCache print buffer files installed from the PrintCache diskette during system installation, configured for the instrument. PrintCache is not required for operation of the instrument, but if it is used, all its files must be in the PCACHE directory.

18.7.4 QEMM DIRECTORY

The QEMM directory contains the Quarterdeck QEMM-386 memory manager files installed from the INSTALL #2 (Memory Manager) diskette. These files have been preconfigured for the Tencor P-2. QEMM is required for operation of the instrument.

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18.7.5 TENCOR DIRECTORY

The TENCOR directory contains programs and data files necessary to run the Tencor P-2 main program. It also contains support programs and subdirectories that support main program functions.

Table 18-3 TENCOR Directory Files

Filename	Description
MOT_CFG.DAT	Main motion configuration file
LEVEL.DAT	Leveling motor parameter file
THETA.DAT	Rotational motor parameter file
XFAST.DAT	Fast X-axis motor parameter file
XSLOW.DAT	Slow X-axis motor parameter file
Y.DAT	Y-axis motor parameter file
Z.DAT	Elevator motor parameter file
P1DBASE.DBD	Database definition file
EGA.EXE	Turns on motor at start-up
P2.EXE	Main Tencor P-2 program for instruments without wafer handler
P2H.EXE	Main Tencor P-2 program for instruments with wafer handler
LOGO_P2.EXE	Displays Tencor logo at start-up
CALIB.SYS	Calibration/system setup file
P1_HELP.SYS	Main help system file (ASCII)
P1DB0.SYS P1DB1.SYS P1DB2.SYS P1DB3.SYS P1DB4.SYS P1DB5.SYS P1DB6.SYS P1DB7.SYS P1DB8.SYS	Prototype database files used by main program to initialize the database when no files are present

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18.7.6 SYS DIRECTORY

The SYS directory contains resident device driver files that are loaded from the DOS CONFIG.SYS file at start-up.

Table 18-4 SYS Directory Files

Filename	Description
CHCDVR.SYS	Shinko printer driver
MICPRINT.FY	3-D character font file
CFGSDR.SYS	SECS configuration program (instruments with wafer handler)
CFG100.EXE	SECS configuration program (instruments without wafer handler)
SIBSDR.SYS	SECS driver (instruments with wafer handler)
SDR100.EXE	SECS driver (instruments without wafer handler)
SDRCONF.CFG	SECS configuration data file (instruments with wafer handler)
TENCOR.CFG	SECS configuration data file (instruments without wafer handler)

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18.7.7 UTIL DIRECTORY

The UTIL directory contains miscellaneous support and driver programs. This directory also contains database utility programs described earlier in this section.

Table 18-5 UTIL Directory Files

Filename	Description
BAKUPCAL.BAT	Copies calibration file to diskette
CHC.COM	Shinko printer driver program
CHC_PAL.COM	Shinko printer driver program
CHKOPT.EXE	Support program used to check if special drivers need to be installed
CONVDB13.BAT	Converts version 1.2 data to format that can be used in software version 1.5
DBCONV13.EXE	Converts version 1.2 data to format that can be used in software version 1.5
DB_PWD.EXE	Displays database password
DEL_1-0.BAT	Removes version 1.0 files
EZIERR.MSG	Error message for setup program
EZR.EXE	Runs printer setup program
GPFX85.EXE	IBM dot matrix printer driver
PCACHE.DOS	PrintCache start-up program for DOS memory manager
PCACHE.MAX	PrintCache start-up program for 386MAX memory manager
PCACHE.QEM	PrintCache start-up program for QEMM-386 memory manager
PRINTER.BAT	Installs printer driver at start-up
PRINTER.DEP	Printer driver start-up program for DOS memory manager and dot-matrix printer
PRINTER.DPJ	Printer driver start-up program for DOS memory manager and HP PaintJet printer
PRINTER.MEP	Printer driver start-up program for 386MAX memory manager and dot-matrix printer
PRINTER.MPJ	Printer driver start-up program for 386MAX memory manager and HP PaintJet printer
PRINTER.QEP	Printer driver start-up program for QEMM-386 memory manager and dot-matrix printer

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Table 18-5 UTIL Directory Files (continued)

Filename	Description
PRINTER.QPJ	Printer driver start-up program for QEMM-386 memory manager and HP PaintJet printer
PRINTSEL.BAT	Selects printer
PRINTSEL.RUN	Printer selection program
PRTSPOOL.BAT	Installed print spooler (e.g., PrintCache) start-up program
PRTSPOOL.RUN	PrintCache installation program, called by PRINTSEL.BAT
SECSCOMM.BAT	Support subprogram to install SECS communications drivers if necessary
VBLAST.BAT	Startup subprogram to install Video Blaster driver if necessary
VGATHERE.EXE	Support program used to test for the presence of VGA card

18.7.8 DB, RECIPE, SEQ, SDATA, AND RDATA DIRECTORIES

The DB, RECIPE, SEQ, SDATA, and RDATA directories contain active database files. Starting with version 1.2, these files are write-protected to prevent accidental deletion. The internal format of these files is not normally accessible to other programs. If these directories do not exist, they will be created and their files will be initialized at program start-up.

DB DIRECTORY

Table 18-6 DB Directory Files

Filename	Description
P1DBID.DAT	Primary ID record file
P1DBIDN.DAT	Secondary ID record file
P1DBIDK.KEY	Main key file
P1DBDEF.KEY	Recipe and Sequence key file
!???????.EXT	Raw trace data file (? corresponds to a digit 0 - 9)

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RECIPE DIRECTORY

Table 18-7 RECIPE Directory Files

Filename	Description
P1DBRCP.DAT	Recipe record file

SEQ DIRECTORY

Table 18-8 SEQ Directory Files

Filename	Description
P1DBSEQ.DAT	Sequence program record file

SDATA DIRECTORY

Table 18-9 SDATA Directory Files

Filename	Description
P1DBSUMM.DAT	Summary record file
P1DBSTAT.DAT	Statistics record file
P1DBSAMP.DAT	Sequence results record file

RDATA DIRECTORY

Reserved for future storage of active database files; used in version 1.0 for storage of trace data.

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18.7.9 HELP DIRECTORY

The HELP directory contains help screen files. If this directory does not exist, help screens are not available. Although these are ASCII files, you should not alter them.

Table 18-10 HELP Directory Files

Filename	Filename	Filename
HPSEQVW1.ASC	HPRECCAT.ASC	HPCFGFOR.ASC
HPSEQVW2.ASC	HPDATVW.ASC	HPCFGDAT.ASC
HPSEQRCL.ASC	HPDATRCL.ASC	HPCALCAL.ASC
HPSEQCAT.ASC	HPDATCAT.ASC	HPCALSTY.ASC
HPRECVW.ASC	HPCFGCOL.ASC	ALPHWIN.ASC
HPRECPAR.ASC	HPCFGPTH.ASC	-
HPRECRCL.ASC	HPCFGSET.ASC	-

18.7.10 EXP DIRECTORY

The EXP directory contains the data exported from the Tencor P-2 main program. This directory will not be present until some data has already been exported; the program creates this directory automatically if necessary. Export files are ASCII files whose format is described in Appendix C, "Exporting Data." These files are user files that you can modify to fit your needs. Note that the main program can overwrite files in this directory at any time.

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19 THEORY OF OPERATION

19.1 INTRODUCTION

This section describes the theory of operation of the Tencor P-2 Long Scan Profiler. It discusses both external and internal factors that affect a profile trace.

19.1.1 SYSTEM DESCRIPTION

The Tencor P-2 characterizes a surface by scanning it with a diamond stylus. The resulting trace represents a cross-sectional view with high vertical and spatial resolution. The Profiler can measure artifacts that are only 50Å (0.005 μm or 0.2 μin.) high, determine whether a surface is flat, or whether it has any regular pattern of texture. The Profiler also can make a wide variety of analyses of the surface texture that allow optimization of the surface for particular applications.

The Tencor P-2 digitizes the data signal to permit easy and precise quantization of the results. In addition, the Tencor P-2 computer provides storage facilities for data, Scan recipes, and programs for automatic sequential measurements. It also allows many data analysis functions and flexibility of use through its extended software.

The Tencor P-2 is a stylus scan instrument with a scan length of 210 mm. It has a capacitive sensor that registers the vertical motion of the stylus. The measurement stage rests on an optical flat reference that ensures smooth and stable movement across the scan length. The guide bar for the stage provides straight, directional movement of the stage beneath the stylus. Measurement noise from the instrument itself, which would distort the accurate analysis of surface roughness, is limited by decoupling the mechanisms of the scan motion from other motions within the instrument.

19.1.2 ENVIRONMENTAL EFFECTS

The uncontrolled features of the environment can interfere with the fidelity of the output data. Environmental interferences can be mechanical, acoustical, thermal, and electrical in nature. Loud noises and strong, pulsating air currents from air conditioning blowers also can generate nanometer signals.

Air currents of varying temperatures or of undulating velocities can cause differential heating or cooling of the profiler components. This can generate error signals or noise. Electrical interferences are always possible though not likely in modern designs.

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To obtain optimum performance:

1. Maintain floor vibration less than 0.2 mG (where G=gravitational force, approximately 32 ft/s^2 or 9.8 m/s^2).
2. Maintain the ambient temperature within the following instrument specifications:

   Range should be 21 ±5° C (72 ±9° F)

   Maximum rate of change: 2° C per hour.

19.2 APPLICATION

19.2.1 STEP HEIGHT MEASUREMENTS

High accuracy measurements are easy to make on clean geometry and smooth surfaces, as in Fig. 19-1. One quarter percent (0.25%) precision is attainable above 0.4 μm (16 μin.) step height. This precision can be reached by having a noise level that is small relative to the step height, negligible instrument drift, and calibration by an accurate height standard specimen.

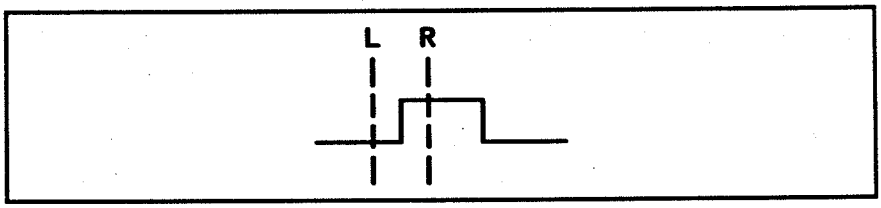


Figure 19-1 Step Height Measurement of a Smooth Surface

The Tencor P-2 has near zero electronic drift, is temperature compensated, and offers a precise software calibration technique. When the surfaces are rough as in Fig. 19-2, or the height of the step is small enough that noise becomes evident in the trace, each measurement cursor can be spread to average portions of the trace to preserve precision nearly that of Fig. 19-1. This technique is called Delta Averaging and is displayed in Fig. 19-2.

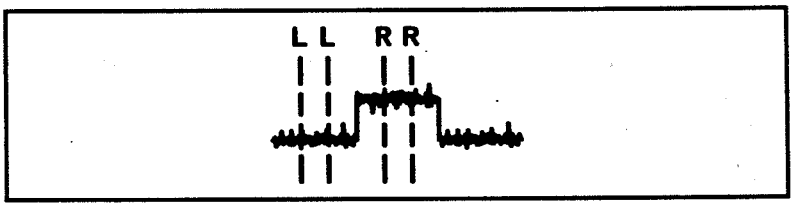


Figure 19-2 Delta Averaging

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A high resolution depiction of a trace will show distortion in the rise and fall of the trace. It does not show perfectly square corners and there is slope in the verticals, as seen in Fig. 19-3. Three factors can contribute to this condition: the stylus geometry, input filtering that imposes a short wave cutoff, and the effect of scan speed on the value of the short wave cutoff wavelength.

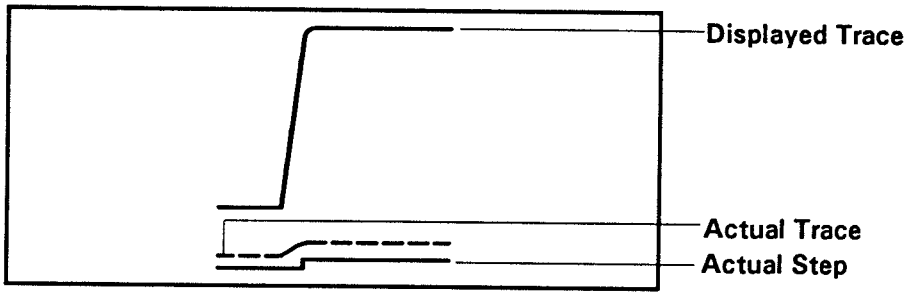


Figure 19-3 Travel Path of the Stylus

STYLUS GEOMETRY

The first factor contributing to the distortion of a step height is the size and shape of the stylus tip. The dotted line in Figs. 19-4 and 19-5 describes the travel path of the stylus radius. Under two worst-case scenarios, Fig. 19-4 displays the case of a step significantly higher than the stylus radius, and Fig. 19-5 displays the case of a groove width approximately equal to the stylus radius.

If a perfectly square step is assumed, the arcs in the trace are inverted replicas of the stylus radius while the slope of the trace in Fig. 19-4 is a replica of the stylus tip angle (typically 60°). Note: The length of the trace of the groove is shorter than the actual length. The traces do not look like this on the instrument's display because the vertical dimensions are greatly exaggerated, perhaps 1000 times the horizontal dimensions, thereby minimizing any distortion.

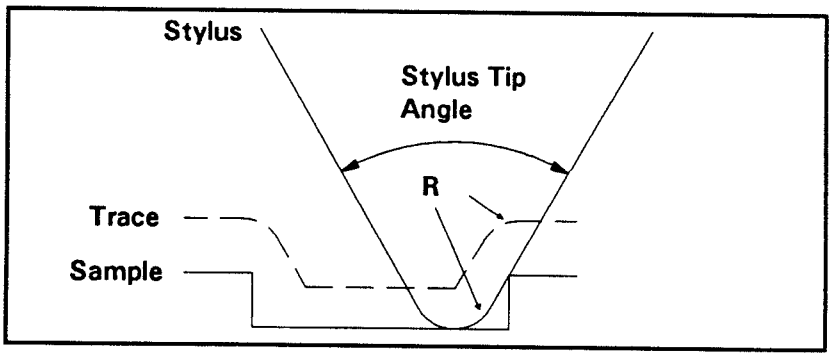


Figure 19-4 Effect of Stylus Radius and Stylus Tip Angle on a High Step

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The distortion due to the stylus does not interfere with accurate measurement of step height. The only case in which an inaccuracy would occur is if the groove is too narrow for the stylus (Fig. 19-5). This causes the stylus to not reach the bottom of the groove, and a falsely low height measurement is recorded.

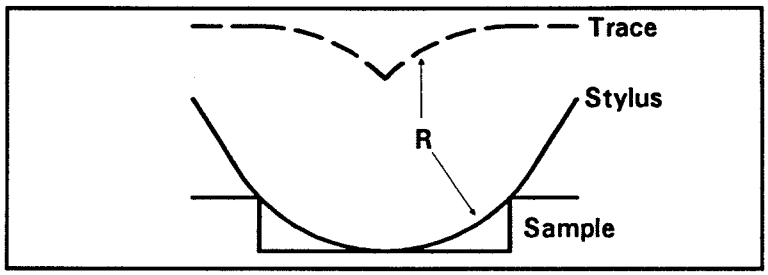


Figure 19-5 Effect of Stylus Radius on a Narrow Groove

Groove width loss is defined as the length of the groove that is not traced (displayed) by the stylus. Figure 19-6 and Table 19-1 show a graph and table of groove depth versus groove width loss for different stylus radii. The significance of this table is that if groove width is to be measured, its width must be greater than the groove width loss.

Table 19-1 Groove Width Loss for Different Radii and Groove Depths

Stylus Radius (μm)	Groove Depth (μm)											
	.02	.05	.1	.2	.4	.8	1.6	2.5	5	10	20	25
12.5	1.4	2.2	3.2	4.5	6.3	8.8	12	15	20	26	38	43
5.0	.89	1.4	2.0	2.8	3.9	5.4	7.3	8.7	12	17	29	35
2.0	.56	.89	1.3	1.7	2.4	3.2	4.2	5.2	8.1	14	25	31
1.0	.40	.62	.87	1.2	1.6	2.1	3.0	4.0	6.9	13	24	30
0.4	.25	.39	.53	.69	.92	1.4	2.3	3.4	6.2	12	24	29
0.2	.17	.26	.35	.46	.69	1.2	2.1	3.1	6.0	12	23	29
0.0	.02	.06	.12	.23	.46	.92	1.9	2.9	5.8	12	23	29

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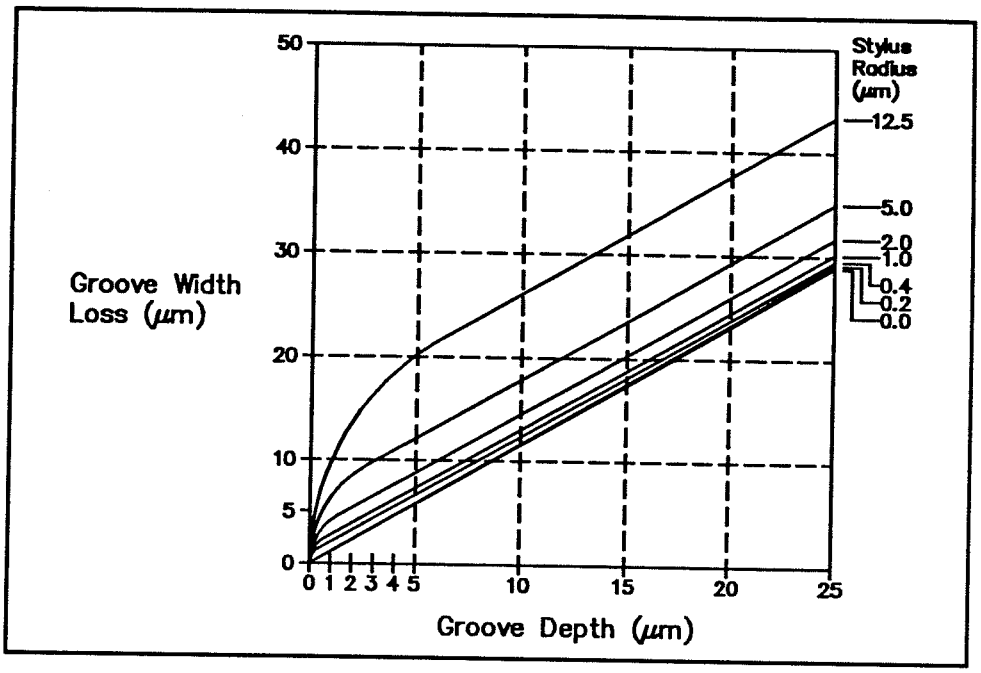


Figure 19-6 Stylus Radius and Groove Width Loss Relation

The 0.0 entry for stylus radius in the above figure corresponds to the theoretical limit of a point stylus on a shank with 60° angle.

THE FILTERING EFFECT OF SCAN SPEED

Another possible cause of height attenuation is the effect of the input filter. An input filter is included in measurement systems to reduce noise and, in the case of digitized instruments, to prevent aliasing effects in the A to D converter.

The cutoff frequency of the input filter is typically one-tenth the data input sampling rate. Note that it passes lower frequencies, which means longer wavelengths for profilers. Since the filter is fixed in frequency, the short wave cutoff value varies with scan speed according to the following relationship:

$$Short\ Wave\ Cutoff = \frac{Scan\ Speed}{Frequency\ of\ Cutoff}$$

The short wave cutoff curves for four decades of scan speed are shown in Fig. 19-7. Since the Tencor P-2 speeds progress in the 1-2-5, 10-20-50, etc., step method and since the wavelength scale of the graph is logarithmic, the second and fifth steps can be plotted at 30% and 70% spacings, respectively, in the decade.

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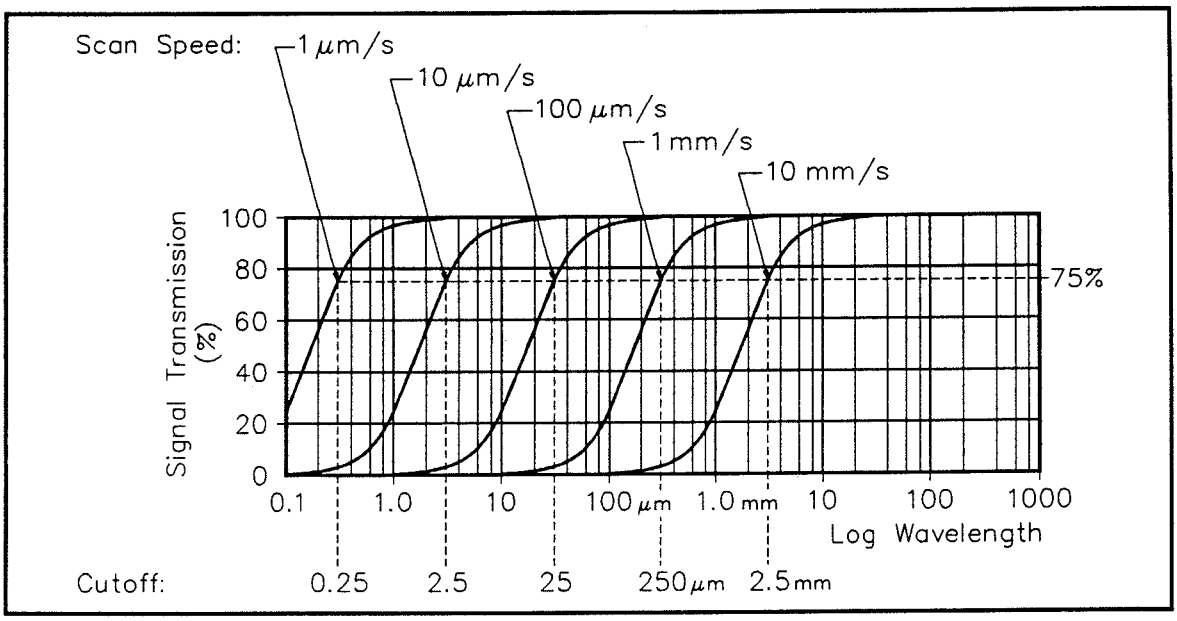


Figure 19-7 Short Wavelength Cutoff Curves

According to the definition by the American Roughness Standard, ANSI/ASME B46.1-1985, the cutoff is specified at the point of 75% signal transmission. The cutoffs in this case vary from 0.25 μm to 2.5 mm of wavelength as the scan speed progresses from 1 μm/s to 10 mm/s respectively. Short wave cutoff values corresponding to any scan speed can be computed using the above equation and 4.0 Hz as the cutoff frequency. In conclusion, *the short wavelength data is lost as scan speed increases.*

If a surface wave is sinusoidal and its wavelength is the same as the input filter cutoff, then its height will be attenuated by 25%. Note, however, that approximately 1% height loss would occur when the wavelength is five times the input filter cutoff. Non-sinusoidal waves are affected in more complicated ways.

The effects of changing short wave cutoffs on a trace are shown in Fig. 19-8 through Fig. 19-10. The sample consists of 3 μm-wide square bars and spaces in oxide, which is 4282Å thick.

The trace measurements were taken using a 0.6 μm stylus radius. In these examples, the scan speed is increased from 1 μm/s to 10 μm/s, which causes the cutoff wavelength to vary from .25 μm to 2.5 μm.

Figure 19-8 displays that at 1 μm the shape and height are faithfully reproduced. The average of the rise and fall distances is 0.8 μm. Approximately 0.68 μm of this is attributable to the stylus radius and 0.12 μm is the input filter contribution. Both of these effects are evident in the top and bottom of the step.

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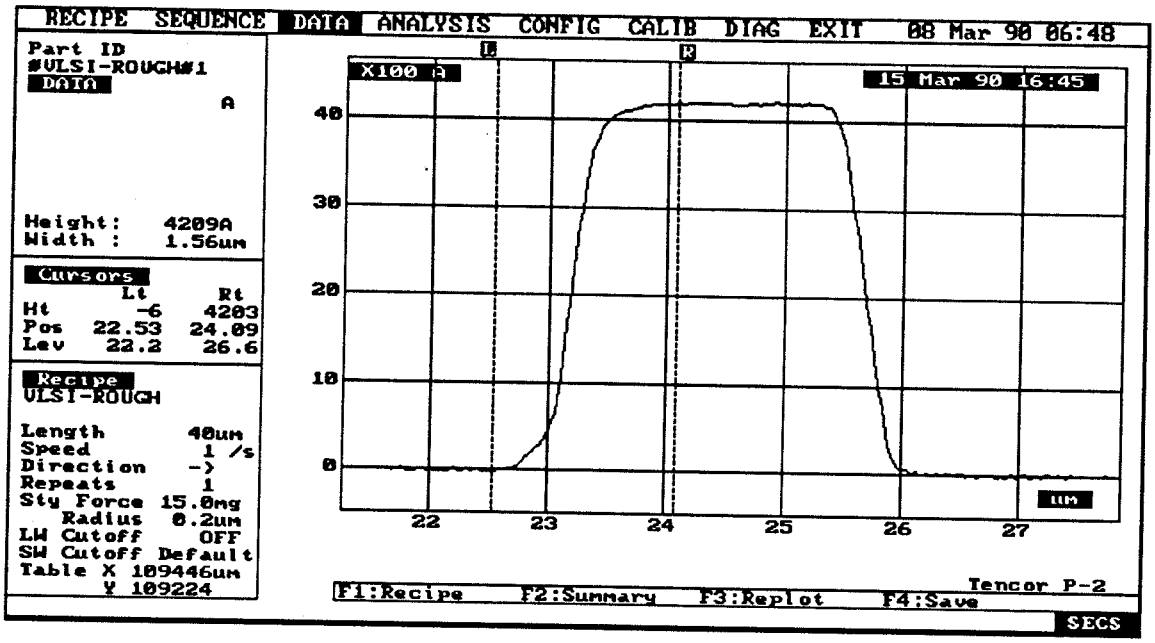


Figure 19-8 Trace at 1 μm/s Speed

The filter cutoff value at 5 μm/s is 1.25 μm in Fig. 19-9 below. This severely distorts the corners of the square wave and causes the center of the peak to shift to the right. Height is only slightly reduced.

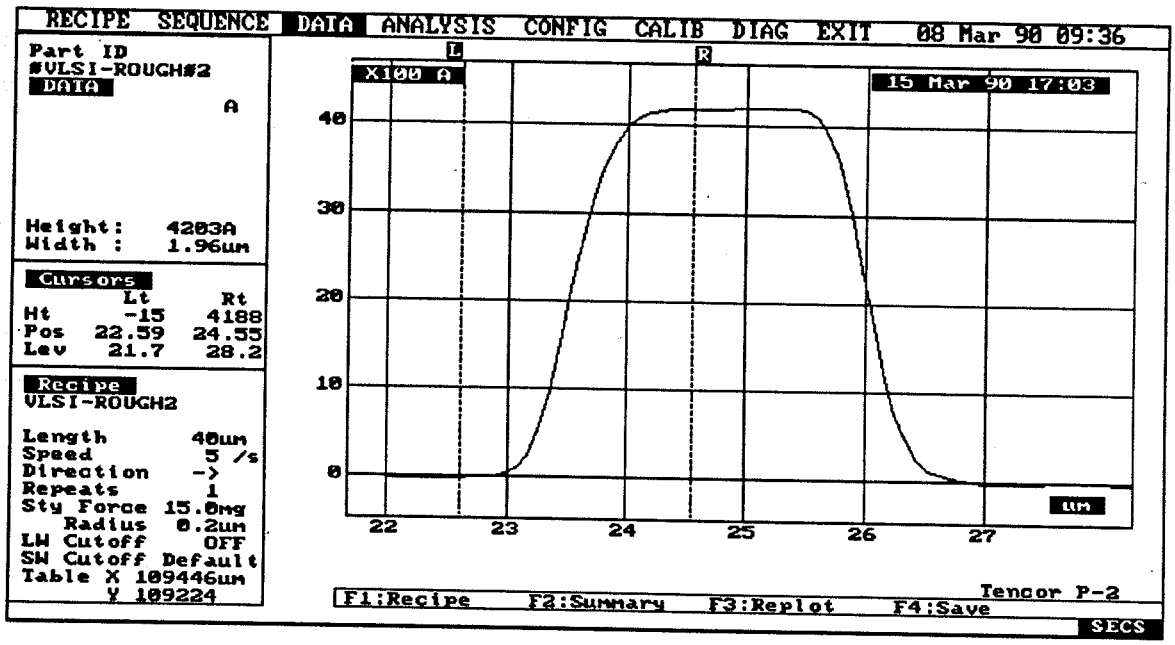


Figure 19-9 Trace at 5 μm/s Speed

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The trace at 10 μm/s in Fig. 19-10 below has become a sine wave with its height attenuated by 4%.

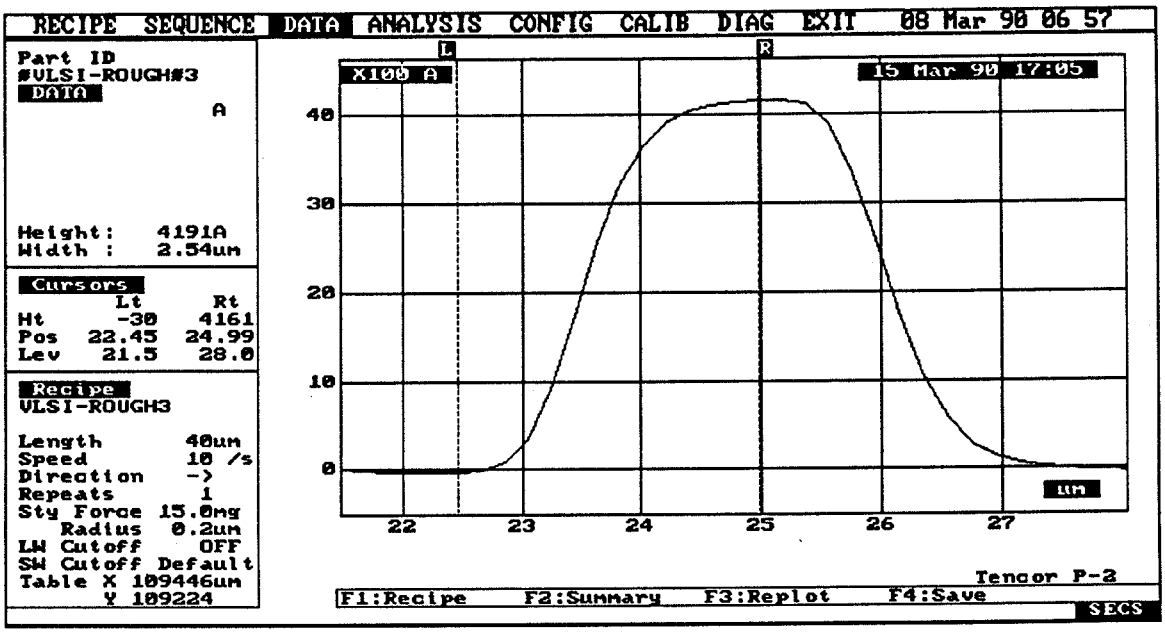


Figure 19-10 Trace at 10 μm/s Speed

19.2.2 SURFACE TEXTURE ANALYSIS

The study and classification of surface texture have been underway for approximately 50 years. The subject is inherently complicated because of the large range of size and shape of surface artifacts as well as the great variety of surface generation methods.

There is also a vast divergence of application interests. Researchers have generated many evaluation parameters and at least 24 national standards committees have been assigning names and definitions for the measurement parameters.

SURFACE DESCRIPTIONS

Variations in surface topography can be divided into three general classes based on relative wavelengths of the variations: form error, waviness, and roughness.

Form error is a deviation from a perfect realization of a nominally specified shape. If a surface is nominally flat, its form error can be defined by the deviation from flatness. However, if the deviation from flatness has several waves, then the shape cannot be classified as form error. This error is called waviness. If there are many hundreds of thousands of randomly shaped undulations, this is called roughness. A representation of this is shown in Fig. 19-11.

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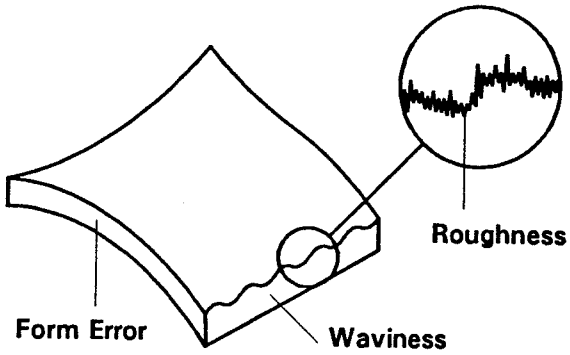


Figure 19-11 Three Classes of Surface Texture

The basic configuration of the Tencor P-2 can separate data into roughness, waviness, and raw data traces as shown in Fig. 19-12. The Band Pass Filter (see Chapter 8, "Data Analysis: Band Pass Filter," for more information) allows further separation of intermediate wavelengths from standard roughness and waviness components.

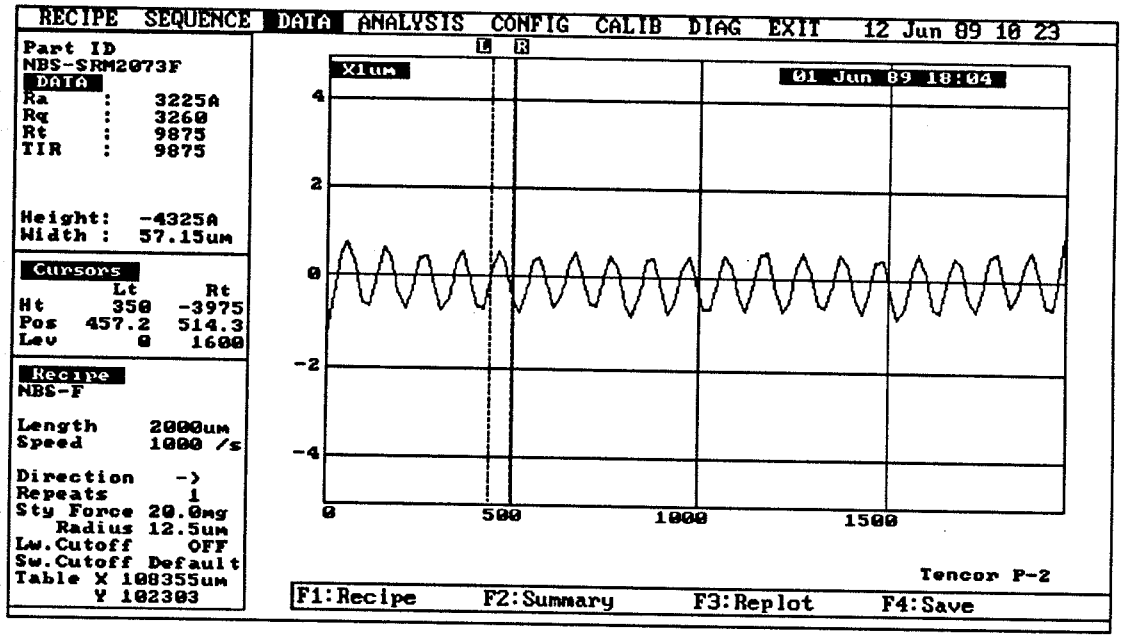


Figure 19-12 Tencor P-2 Separates Surface Texture into Roughness and Waviness

These class divisions of surface variations are arbitrary in that the size of the wavelengths involved depends on the size of the sample being considered. No sharp divisions can be drawn between the categories. When wavebands of the categories are naturally well separated, it is easy to separate their outputs using filtering techniques for separate analyses. An example of this would be a form error = 1 to 3 waves, waviness = 25 to 80 waves, and roughness = 500 to 5000 waves.

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When there is a continuum of wavelengths, there is no way of separating surface variation categories without significant data distortion and the user must find an application-specific method of data analysis that is effective in controlling surface quality.

SURFACE CHARACTERIZATION PARAMETERS

Surface analysis is mostly concerned with the measurement of roughness. The earliest parameter to be developed was roughness average (R_a), which is the arithmetic average of the absolute values of the profile height deviations. These values are taken within the sampling length and are in reference to the graphical centerline. The R_a is defined by the following formula per the ANSI/ASME standard:

$$Ra = \frac{1}{L} \int_{x=0}^{x=L} |y| \, dx$$

where:

R_a = arithmetic average deviation from the centerline
L = sampling length
y = ordinate height of the curve of the profile, relative to the centerline

The R_a provides a good representation for a scale of roughness that is symmetrical about the centerline and has a Gaussian distribution of peak and valley heights. It contains little information about the nature of the roughness, however, and often fails in application correlation (see Fig. 19-13).

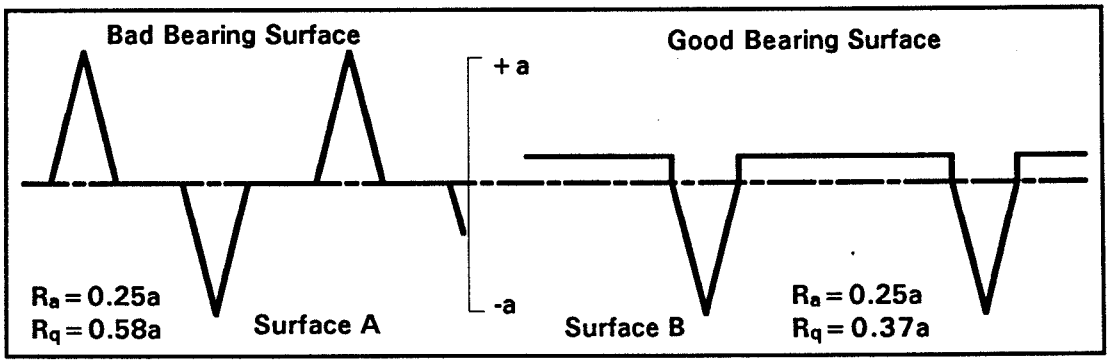


Figure 19-13 Same R_a for Different Surfaces

Surfaces A and B in the figure above produce the same R_a value even though surface A is obviously more rough and is a very bad bearing surface while surface B is an excellent one due to wear considerations and the ability to retain lubricant. A different roughness parameter, R_q, shows a 36% lower value for surface B because it is defined as the RMS average rather than the arithmetic average. The RMS (R_q) is defined per the ANSI/ASME standard as:

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$$Rq = \left[\frac{1}{L} \int_{x=0}^{x=L} y^2 \, dx \right]^{\frac{1}{2}}$$

where:

L = sampling length

y = ordinate height of the curve of the profile, relative to the centerline

Squaring the y values gives emphasis to the large values of y versus the small values so that a distinction is made between surfaces A and B.

Many other parameters, available with the Tencor P-2 and listed in Tables 19-2 through 19-5, have been developed to improve the correlation between a parameter value and a particular surface performance. See Section 5.3.2., "Surface Analysis Fields," and Section 5.3.3, "Additional Surface Roughness Parameters Option," for definitions of these parameters.

Table 19-2 lists the miscellaneous surface analysis parameters of the Tencor P-2.

Table 19-2 Miscellaneous Surface Analysis Parameter Descriptions

Parameter	Description
TIR	Total Indicator Run-out
Ave	Average
Slope	Slope
Rad	Radius
Area+	Area of Peaks
Area -	Area of Valleys
Area	Total Area of Peaks and Valleys
ProfL	Profile Length
MaxHt	Maximum height
MinHt	Minimum height
Edge	Distance to Edge (or Apex)
StpWd	Width of Step
StpN	Number of Steps
StpMn	Mean Step Height
StpSD	Standard Deviation of Step Heights

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The following table lists the roughness parameters of the Tencor P-2.

Table 19-3 Roughness Parameter Descriptions

Parameter	Description
R_a	Arithmetic Average
Max R_a	Maximum of 19 Overlapping Sections
R_q	Root Mean Square (RMS)
R_p	Maximum Height/Peak
R_v	Maximum Depth/Valley
R_t	Maximum Peak-to-Valley
R_z	Ten-Point Height
R_{3z}	Six-Point Height
R_h	Roughness Height

Table 19-4 lists the waviness parameters of the Tencor P-2.

Table 19-4 Waviness Parameter Descriptions

Parameter	Description
W_a	Arithmetic Average
W_q	Root Mean Square
W_p	Maximum Height/Peak
W_v	Maximum Depth/Valley
W_t	Maximum Peak-to-Valley
W_h	Waviness Height

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Table 19-5 lists the extra surface analysis parameters of the Additional Surface Roughness Parameters Option.

Table 19-5 Additional Surface Roughness Parameters Option

Parameter	Description
RPM	Mean Peak Height
D_q	Root Mean Square (RMS) Slope
L_q	Average RMS Wavelength
SD	Standard Deviation Heights
t_p	Bearing Length Ratio (at Cutting Depth)
CD	Cutting Depth (at Bearing Length Ratio)
PC	Peak Count
HSC	High Spot Count
S_m	Mean Peak Spacing

STYLUS GEOMETRY AND SCAN SPEED

The stylus geometry can also affect the roughness data. If the wavelengths on the surface are short relative to the stylus radius, they will not register on the trace or will be greatly attenuated in height. The stylus radius should be small enough to penetrate the bottom of the wave satisfactorily.

Similarly to step height, the horizontal resolution decreases as the speed increases. The scan speed chosen should be consistent with the wavelengths to be measured.

LONG WAVE CUTOFF FILTERS

Filtering is employed to separate the roughness data from the waviness and form error data. The American Roughness Standard ANSI B46.1-1985 specifies the long wave filter characteristic to be that of a 2-pole RC network whose cutoff wavelength is at 75% transmission.

See Fig. 19-7 for transmission curves and cutoff values. Tencor Instruments has added intermediate and extended range values to increase the available list of long wave cutoff filters. See Table 19-6 for a list of the Tencor P-2 values in both metric and English units.

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Table 19-6 Additional Intermediate and Extended Long Wave Cutoff Filters

Long Wave Cutoff Filter Lengths					
μm	mil	μm	mil	mm	mil
4.5	.18	140	5.6	4.5	180
8.0	.30	250[1]	10.0[1]	8.01	300[1]
14	.56	450	18.0	14.0	550
25	1.0	800[1]	30.0[1]	25.0	1000
45	1.8	1.4	56	-	-
80[1]	3.01	2.5	100[1]	-	-

[1] These values are specified in ANSI B46.1-1985.

To separate roughness data from waviness data, the cutoff wavelength should be equidistant between the shortest waviness lengths and the longest roughness lengths. The cutoff wavelength also should be less than one-third of the total scan length (unaffected by zooming the data). *A good rule of thumb would be to start with one-fifth or 20% of the total scan length.*

In the example in Fig. 19-14, 0.25 mm would be the proper choice for the cutoff wavelength, because it is the closest standard length available between the longest roughness (0.1 mm) and the shortest wavelength (0.4 mm). If there is more than a decade of wavelength clearance between roughness and waviness, there should be no problem in finding an appropriate cutoff.

There are occasions when one cutoff does not completely remove waviness and the next lower value attenuates the roughness reading. The user must then make a choice based on the requirements of the application.

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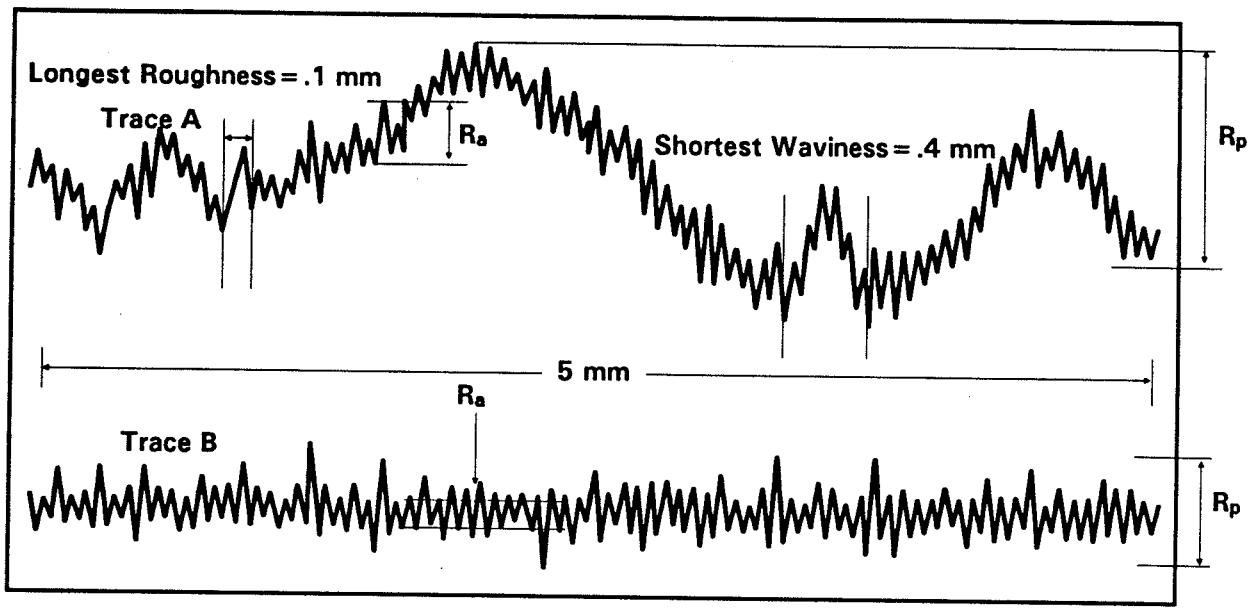


Figure 19-14 Cutoff Wavelength

In trace A, calculations of R_p and R_a include the waviness. When the waviness is filtered out as in trace B, the lower values of R_p and R_a better reflect the fine grain structure of the surface texture.

ROUGHNESS ANALYSIS METHOD

The Tencor P-2 calculates roughness and waviness from digitized data points using the Finite Impulse Response (FIR) technique. The FIR technique filters by convoluting the trace data with the impulse response of the filter specification as defined by the ANSI/ASME standard. The impulse response is obtained by taking the inverse fast Fourier transform of the filter specification. According to the ANSI/ASME standard, the percent transmission of the transfer function for the short wave cutoff is as follows:

$$\frac{100}{1 + 0.33\left[\frac{\textit{Short Wave Cutoff}}{\textit{Wavelength}}\right]^2}$$

For the long wave cutoff, the percent transmission of the transfer function is as follows:

$$\frac{100}{1 + 0.33\left[\frac{\textit{Wavelength}}{\textit{Long Wave Cutoff}}\right]^2}$$

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To calculate roughness, the centerline of the surface wave is found. This centerline is approximately equal to the waviness trace. The roughness data is produced by subtracting the centerline from the raw data. This data is then used to determine parameter values according to their mathematical definitions. This method has advantages of precision, a lack of phase distortion, and a reduced requirement of only three cutoff lengths of trace for full fidelity. Also, in the case that less than three cutoff lengths of trace are available, error probability is reduced by an assumption of continuity of the surface wave before and after the actual trace.

19.3 CONCLUSION

There are many factors that contribute to profiling a surface. Environmental interference as well as stylus geometry and filtering can affect data. Also, as the scan speed increases, the distance between data points increases. These factors must be taken into consideration when determining an application for step height measurement, surface roughness, or waviness.

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APPENDIX A—SPECIFICATIONS

MEASUREMENTS

Roughness	R_a, Arithmetic Average Max R_a, Maximum of 19 overlapping sections R_q, Root-Mean-Square (RMS) R_p, Maximum Height R_v, Maximum Depth R_t, Maximum Peak-to-Valley R_z, Ten-Point Height R_{3z}, Six-Point Height R_h, Height between two points
Waviness	W_a, Arithmetic Average W_q, Root-Mean-Square W_p, Maximum Height W_v, Maximum Depth W_t, Maximum Peak-to-Valley W_h, Height between two points
Topography	
TIR	Total Indicator Run-out
Height	Height between two points (Step Height)
Average Height	Average height of all data points between the measurement cursors relative to the leveled baseline (Delta Average Mode)
Slope	Rate of change of the profile between two points
Radius	Distance from center of curvature of profile arc to the profile
Area of Peaks	Total area bounded by the leveled baseline and the profile above the baseline
Area of Valleys	Total area bounded by the leveled baseline and the profile below the baseline
Total Area	Sum of Area of Peaks and Area of Valleys
Profile Length	Length obtained from drawing out the profile into a straight line
Maximum Height	Maximum height of trace between the measurement cursors relative to the zero line
Minimum Height	Minimum height of trace between the measurement cursors relative to the zero line
Edge	Distance to rising edge or apex from start of profile
Step Width	Width of profile step

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Number of Steps	Number of steps between the measurement cursors
Mean Step Height	Mean value of all the steps between the measurement cursors
Std. Dev. Step Height	Standard deviation of all the steps between the measurement cursors

The following parameters are included in the Additional Surface Roughness Parameters Option.

Mean Peak Height	Mean value of peak heights
RMS Slope	Root-mean-square value of slopes
Average RMS Wavelength	2π times ratio of RMS deviation of R_q to the RMS slope
Standard Deviation Heights	Standard deviation of peak heights
Bearing Length Ratio	Ratio of bearing length to sampling length at chosen value of Cutting Depth
Cutting Depth	Distance below highest peak to reference line giving chosen value of Bearing Ratio
Peak Count	Number of peak/valley pairs per unit length projecting through a band of chosen width centered about mean line
High Spot Count	Number of profile peaks per unit length projecting through a chosen reference line
Mean Peak Spacing	Mean value of the local peak spacing, where peaks are defined as in Peak Count

Long Wave Cutoff Filter Wavelengths

mm	inch	mm	inch	mm	inch
.0045	.0002	0.14	.006	4.5	0.18
.008	.0003	0.25	.01	8.0	0.3
.014	.0006	0.45	.018	14	0.55
.025	.001	0.8	.03	25	1.0
.045	.002	1.4	.055		
.08	.003	2.5	.1		

Short Wave Cutoff Filter Wavelengths

mm	inch	mm	inch	mm	inch
Default[1]		.014	.00056	1.4	.056
.00025	.00001	.025	.0010	2.5	.10
.00045	.00002	.045	.0018	4.5	.18
.00080	.00003	.08	.0030	8.0	.30
.0014	.00006	.14	.0056	14	.56
.0025	.00010	.25	.010	25	1.0
.0045	.00018	.45	.018		
.008	.00030	.80	.030		

[1] Default cutoff filter values differ depending on scan speed and sampling rate. See Table 8-1 in Chapter 8, "Data Analysis: Band Pass Filter."

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PROFILING PERFORMANCE

STANDARD MEASUREMENT HEAD (STYLUS FORCE: 1–100 mg)

	Metric	English
Scan Length	210 mm	8.2 in. maximum
Scan Speed	1 μm/s to 25 mm/s	0.04 mil/s to 1 in./s
Sampling Rate	50, 100, or 200Hz nominal	
Vertical Range		
At 1Å (0.004 μin.) Resolution:	± 6.5 μm	± 0.25 mil maximum
At 25Å (0.1 μin.) Resolution:	± 150 μm	± 6 mil maximum
	+20/-280 μm	+0.8/-11 mil or
	+280/-20 μm	+11/-0.8 mil
Vertical Linearity, below 2000Å	10Å	0.04 μin
Vertical Linearity, above 2000Å	± 0.5%	± 0.5%

NOTE: **Because the instrument linearity guarantee is significantly smaller than the uncertainty of the step height standards available in the range of typical use of the instrument, *step height standards cannot be used to verify the linearity of the instrument.***

	Metric	English
Horizontal Resolution		
At 1 μm/s scan speed	0.01 μm (100Å)	0.4 μin.
Scan Method	Moving stage, stationary stylus	
Stylus Control	Programmable Force:	
Range		1.0–100 mg
Resolution		0.1 mg
	Full retract between scans	
	Programmable descent rate	
Optical Magnification		
Standard:	150–600x	
Low Magnification Option:	60–240x	

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MICROHEAD LOW MOMENT MEASUREMENT HEAD (STYLUS FORCE: 0.05–15 mg)

	Metric	English
Scan Length	210 mm	8.2 in. maximum
Scan Speed	1 μm/s to 25 mm/s	0.04 mil/s to 1 in./s
Sampling Rate	50, 100, or 200Hz nominal	
Vertical Range		
At 0.5Å (0.002 μin.) Resolution:	± 3.25 μm	± 0.13 mil maximum
At 2Å (0.008 μin.) Resolution:	± 13 μm	± 0.5 mil maximum
At 10Å (0.04 μin.) Resolution:	± 65 μm	± 2.6 mil maximum
Vertical Linearity, below 2000Å	10Å	0.04 μin
Vertical Linearity, above 2000Å	± 0.5%	± 0.5%

> **NOTE:** Because the instrument linearity guarantee is significantly smaller than the uncertainty of the step height standards available in the range of typical use of the instrument, ***step height standards cannot be used to verify the linearity of the instrument.***

	Metric	English
Horizontal Resolution		
At 1 μm/s scan speed	0.01 μm (100Å)	0.4 μin.
Scan Method	Moving stage, stationary stylus	
Stylus Control	Programmable Force:	
	Range	0.05–15 mg
	Resolution	0.05 mg
	Full retract between scans	
	Programmable descent rate	
Optical Magnification		
Standard:	4.0x objective (220–870x)	
	6.3x objective (350–1370x)	
Optional:	3.1x objective (180–680x)	
	10x objective (500–2000x)	

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EXTENDED RANGE MICROHEAD (STYLUS FORCE: 0.5–45 mg)

	Metric	English
Scan Length	210 mm	8.2 in. maximum
Scan Speed	1 μm/s to 25 mm/s	0.04 mil/s to 1 in./s
Sampling Rate	50, 100, or 200Hz nominal	
Vertical Range		
At 1Å (0.004 μin.) Resolution:	± 6.55 μm	± 0.26 mil maximum
At 10Å (0.04 μin.) Resolution:	± 65 μm	± 2.6 mil maximum
At 50Å (0.4 μin.) Resolution:	± 325 μm	± 12.8 mil maximum
Vertical Linearity, below 2000Å	10Å	0.04 μin
Vertical Linearity, above 2000Å	± 0.5%	± 0.5%

> **NOTE:** Because the instrument linearity guarantee is significantly smaller than the uncertainty of the step height standards available in the range of typical use of the instrument, ***step height standards cannot be used to verify the linearity of the instrument.***

	Metric	English
Horizontal Resolution		
At 1 μm/s scan speed	0.01 μm (100Å)	0.4 μin.
Scan Method	Moving stage, stationary stylus	
Stylus Control	Programmable Force:	
	Range	0.5–45 mg
	Resolution	0.1 mg
	Full retract between scans	
	Programmable descent rate	
Optical Magnification		
Standard:	4.0x objective (220–870x)	
	6.3x objective (350–1370x)	
Optional:	3.1 objective (180–680x)	
	10x objective (500–2000x)	

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REPEATABILITY AND STABILITY

Step Height Repeatability–Standard Measurement Head

13 μm (± 6.5 μm) range	0.001 μm (10Å) maximum standard deviation
300 μm (± 150 μm) range	0.005 μm (50Å) maximum standard deviation
	Note: The Step Height Repeatability has been verified using step height standards from VLSI Standards with a sequence of fifty 10-s measurements at a single position.

Step Height Repeatability–Optional MicroHead Low Moment Measurement Head

± 3.25 μm range	0.0006 μm (6Å) maximum standard deviation
	Note: The Step Height Repeatability has been verified using step height standards from VLSI Standards with a sequence of fifty 10-s measurements at a single position.

Step Height Repeatability–Optional Extended Range MicroHead

± 6.55 μm range	0.001 μm (10Å) maximum standard deviation
	Note: The Step Height Repeatability has been verified using step height standards from VLSI Standards with a sequence of fifty 10-s measurements at a single position.

Base Line Stability

Time	0.02 μm (200Å) maximum TIR for a 100-s no motion scan
Distance	0.2 μm (2000Å) maximum TIR on a profile length of 130 mm verified on a 1/20 optical flat

Measurement Environment	Floor vibration below 0.2 mG
	Audio noise below 80 dB
	Ambient temperature range 16–26° C
	Maximum rate of change 2° C/hour

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MEASUREMENT CONTROL

Manual/Single Scan Mode

Continuous or segmented scan, from recipe

Keylock with three Modes

Position 1: Run a single recipe or sequence without modification.
Position 2: Run any recipe or sequence without modification.
Position 3: Unlocked. All functions available including interlock setting.

Repeat and Average Mode

Scan repeated up to ten times and averaged

Automatic Sequence Mode

Up to 300 recipes and locations combined into a sequence of recipes (optional)

SAMPLE HANDLING

Motorized X-Y

Two programmable locations (Standard Config.)
Unlimited programmability (Automatic Config.)

Manual Control

Via trackball or keyboard

Maximum Sample Size

Metric	English
254 x 254 mm	10 x 10 in.

Note: 355 x 355 mm (14 x 14 in.) with side panel removed
Note: Stylus can access any part of a 210-mm (8.2-in.) round sample without sample repositioning.

Open Frame Configuration

Without Removable Isolation Hood:

480 x 480 mm	19 x 19 in.

With Removable Isolation Hood:

430 x 430 mm	17 x 17 in.

Note: Inside space of hood is 743 mm (29.25 in.) X, 556 mm (23.1 in.) Y. A 480-mm (19-in.) sample has full 210 mm (8.2 in.) of scan or positioning motion in the X direction but only 100 mm (4 in.) in the Y direction.

Note: Stage Table: 243 x 243 mm (9.57 x 9.57 in.) with switchable vacuum to handle wafer sizes of 100 mm (4 in.) to 200 mm (8 in.). Accommodates

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	Tencor P-2 sample locators. Note: The stylus can access, without sample repositioning, one 210-mm (8.2-in.) diameter area or a 145-mm (5.7-in.) square area. Also, the stylus can access 86% of a 355-mm (14-in.) or 73% of a 430-mm (17-in.) square sample when the sample is moved to each of four or five positions respectively.	
Maximum Sample Weight	2.2 kg	5 lb
Throat Depth	228 mm	9 in.
Throat Height, incl. Rotary Stage	63.5 mm	2.5 in.
X,Y Maximum Travel	210 mm	8.2 in.
Stylus and Sample Programmed Position Repeatability (1σ)	2 μm	0.08 mil.
X,Y Positioning Speed	Variable up to: 25 mm/s	 1 in./s
Manual Stage Rotation	Unlimited rotation. Can be set with six detents (four at 90°, two at ± 45°)	
Motorized Stage Rotation		
Angle Resolution	0.001 degrees	
Position Repeatability (1σ)	4 μm (at 4 in. from center)	0.16 mil
Leveling	Electronic leveling of traces is standard. Automatic mechanical leveling of sample with Motorized Level and Rotation Option	
Vacuum Hold-Down of Sample	Standard with either of the rotating stages	
Custom Fixturing Interface	Three 8-32 UNC 2B threaded holes on 3.16-in. diameter circle, 90° apart. Three 1/8-in. diameter locating holes on 3.74-in. diameter circle, 90° apart.	
Standard Precision Locator	(See Appendix E, "Ordering Information.")	

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DATA STORAGE

Hard Disk

120 MB. Stores over 20000 scans at 1000 points each.

Diskette

1.4 MB, 3.5 in. Data storage limited to approximately 100 recipes and 200 scans at 1000 points each. (300 scans per diskette dedicated to data.)

Storage Requirements

The following figures are estimates only.
DOS Operating System: approx. 80 KB
Tencor P-2 Program: approx. 720 KB
Recipe: 215 bytes
Sequence Program: 728 bytes + 683 bytes for each 27 locations
Single-scan data: 652 bytes + trace data
Sequence data: 420 bytes + 512 bytes per recipe + 292 bytes per location + trace data per location
Trace data: Trace data storage requirements are added to that for the scan data.
2-D trace data: 2122 bytes for the first 505 data points + 2048 bytes for each additional 512 data points
3-D trace data: 2122 bytes minimum + 2048 byte increments
32 bytes per trace (range 1 to 210 inclusive)
4 bytes per data point
Approximate number of data points = number of traces × scan length × sampling rate / scan speed

DATA ANALYSIS

Interactive Graph

Two cursor read-out. Cursors move independently or in tandem.

Delta Average Mode

Each cursor is expandable into a region for measurement or leveling

Zoom Box Data Expansion

Portion of a graph can be magnified

Data Catalog

Immediate data retrieval and display from catalog

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Database Manager Option

For each recipe in a given sequence: data table with statistics of mean, standard deviation, minimum, maximum, and range for up to 20 surface analysis parameters. Recall or purge data saved on disk using up to seven user-labeled identifiers in addition to recipe and sequence identifiers, dates.
Data can be formatted for PC/AT compatible programs.

Metric/English Units

Parameters displayed in preprogrammed metric or English units; independent selection of horizontal and vertical parameters.

EQUIPMENT SPECIFICATIONS

Processor

80486-33 MHz controller, PC/AT compatible, runs MS-DOS Operating System, version 5.x.

Screen

Displays magnified image of the sample or output data. Initial data trace or cross-hair identification of stylus location relative to stage can be superimposed on sample image.
33 cm (13 in.) diagonal
High resolution: 640 x 350 pixels
Color data display, user-selectable colors
Variable image magnification:
150–600X standard.
60–240X optional, factory only.
Motorized zoom with keyboard control
Filtered illumination of sample
(Yellow-red wavelength only)

Console

Built-in keyboard and trackball to program and operate instrument

Remote Keyboard

Removable keyboard enabling use of PC/AT software (optional)

Real Time Clock

Battery-backed clock provides date and time of day

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PHYSICAL SPECIFICATIONS

Tencor P-2 without Wafer Handler

	Metric	English
Dimensions		
Width	57 cm	22.5 in.
Height	75 cm	29.3 in.
Depth	78 cm	30.6 in.
Open Frame Configuration		
Width (with hood)	75 cm	29.3 in.
(without hood)	57 cm	22.5 in.
Depth	90 cm	35.6 in.
	Note: Feet will fit on a 76-cm (30-in.) deep table.	
Hood Door Opening	55 cm	21.9 in.
Overall Width (with hood)	75 cm	29.3 in.
(without hood)	57 cm	22.5 in.
Weight		
Instrument	118 kg	260 lb
Shipping Weight	197 kg	435 lb
Open Frame Configuration		
Instrument Weight	127 kg	280 lb
Electrical	108–130 V, 50/60 Hz 90–110 V, 50/60 Hz 180–260 V, 50/60 Hz Power requirements: 150 VA	

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Tencor P-2 with Wafer Handler (Floor Mount)

Dimensions	**Metric**	**English**
Width	117 cm	46.0 in.
Height	154 cm	61.0 in.
Depth	78 cm	30.6 in.
Weight		
Instrument	231 kg	510 lb
Shipping Weight	354 kg	780 lb
Electrical	108–130 V, 50/60 Hz 90–110 V, 50/60 Hz 180–260 V, 50/60 Hz Power requirements: 210 VA	

Tencor P-2 with Wafer Handler (Table Mount)

Dimensions	**Metric**	**English**
Width	117 cm	46.0 in.
Height	81 cm	32.0 in.
Depth	78 cm	30.6 in.
Weight		
Instrument	177 kg	390 lb
Shipping Weight	311 kg	685 lb
Electrical	108–130 V, 50/60 Hz 90–110 V, 50/60 Hz 180–260 V, 50/60 Hz Power requirements: 210 VA with handler	

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APPENDIX B—INSTALLING UPGRADED TENCOR P-2 SOFTWARE

CONTENTS OF INSTALLATION PACKAGE

The upgrade installation package consists of three Install diskettes:

1. System and Utilities (also serves as instrument Boot diskette)
2. Memory Manager (pre-configured QEMM-386 files)
3. Application

The package might also include one or more of the following depending on which options you have ordered and what version of previous Tencor P-2 software you are upgrading from:

- One Options diskette
- One database tutorial diskette
- One copy of MS-DOS 5.0 Upgrade
- One copy of QEMM-386 Memory Manager
- One copy of PrintCache printer buffer software

BASIC INSTALLATION PROCEDURE

The basic installation procedure replaces the existing CONFIG.SYS and AUTOEXEC.BAT files on the instrument. If the instrument has been specially configured for network connection or specific TSR programs, be sure to save the current CONFIG.SYS and AUTOEXEC.BAT files before installing the version 1.6.1 software (see below).

To install the upgraded Tencor P-2 software:

1. If MS-DOS 5.0 has not been installed on the instrument, install it according to its installation instructions. Be sure to back up your CONFIG.SYS and AUTOEXEC.BAT files before starting, because the MS-DOS 5.0 setup program modifies them in such a way that they cannot be used on the instrument. After DOS setup, do not reboot immediately but go to the next Profiler software installation step.
2. Insert the INSTALL #1 (System and Utilities) diskette and press the RESET button. After a brief time the instrument asks if you wish to install the profiler software. Type *y* and press ENTER.

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3. The instrument asks you whether a Tencor Instruments wafer handler is installed on the instrument. Type *y* for Yes or *n* for No, as appropriate. Note that only the Tencor wafer handler is supported by the handler-specific version of the instrument software; any other handler is treated as "No handler" for installation purposes.

4. The install program proceeds with the installation, copying files from the diskette to the instrument's hard disk. After a brief time, the instrument prompts you to insert the INSTALL #2 (Memory Manager) diskette. Do so, then press any key to continue the installation process.

5. The instrument asks you which supported printer you wish to install. Type the number corresponding to the desired printer (if in doubt, type *1* for an Epson/IBM-compatible dot-matrix printer) and press ENTER.

6. The instrument asks if you wish to install the PrintCache print spooler. If yes, type *y* and press ENTER. The instrument will ask you to insert the PrintCache installation diskette. Follow the PrintCache Installation Procedure described below.

Note:	**PrintCache is not required for operation of the instrument unless you are using a Hewlett-Packard PaintJet printer. In that case, PrintCache must be loaded or the system will be corrupted.**

7. The instrument prompts you to insert the INSTALL #3 (Application) diskette. Do so, then press any key to continue the installation process.

8. After copying more files to the hard disk, the instrument asks if you wish to upgrade the installed options. If you have an Options diskette with your installation package, type *y* and press ENTER. Follow the displayed instructions to install your new options. If you do not have an Options diskette, type *n* and press ENTER.

9. When instructed, reinsert the INSTALL #1 diskette.

10. When the instrument informs you that the installation has successfully completed, remove the diskette and press the RESET button. The instrument starts up the version 1.6 main program as it did previous versions. Verify from the information on the screen that all expected options are enabled.

11. Return to DOS and make sure you are in the C:\TENCOR directory. If not, type *cd \tencor* and press ENTER. Slide the write-protect tab on the INSTALL #3 (Application) diskette to the write-enable position (towards the front of the diskette, so that the small rectangular opening is not blocked). Insert the diskette into the floppy drive. Type the command *backupcal* and press ENTER. Note for beta test site users: If you have been running the instrument software from a directory other than C:\TENCOR, be sure to type the *backupcal* command from that directory.

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12. Remove the INSTALL #3 diskette from the drive. Slide the write-protect tab back into the write-protect position (blocking the small rectangular opening).

PRINTCACHE INSTALLATION PROCEDURE

The installation program delivered with the PrintCache print spooler has been integrated into the Profiler software installation program. It is necessary to use the 3.5-in. PrintCache diskette to install it. The instrument startup programs have been preconfigured to sense whether PrintCache has been installed and to start it up configured for the selected printer. For the preconfigured startup programs to work, follow the PrintCache installation procedure exactly as described. The PrintCache installation program has a light-blue screen and is set up as a series of interactive queries. Always press ENTER to make a selection.

To install the PrintCache software:

1. When prompted, insert the 3.5-in. PrintCache installation diskette into drive A and press ENTER.
2. Select the default hard disk C (critical step).
3. Select the default PrintCache directory C:\PCACHE (critical step).
4. Select the appropriate printer type; for unsupported printer types, refer to the PrintCache manual.
5. Select LPT1: for the printer connection port (critical step).
6. Skip the printer port configuration test (not necessary, pre-configured).
7. Select LPT1: for the input port to the PrintCache buffer (critical step).
8. Select Disk Drive C: for the buffer type (critical step).
9. Select 1 MB for the default buffer size.
10. Do not enable the Pop-up Menu.
11. Skip the update of AUTOEXEC.BAT (critical step). Startup of PrintCache has been pre-configured.
12. Skip Windows installation unless the instrument is also being used as a Windows workstation.
13. Skip the printout of the settings.
14. Skip display of the README file unless you need information on printers not supported by Tencor Instruments.
15. Skip the printer port test unless there is a suspected problem in the printer port.
16. Continue the Tencor P-2 installation at Step 7 of "To install the upgraded Tencor P-2 software" in the "Basic Installation Procedure" earlier in this Appendix.

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NOTE: **For users upgrading to Tencor P-2 software version 1.6.1 from versions prior to 1.4.2, it is necessary that you convert any recipes, sequences, and data that was created with the older version if you wish to use it with version 1.6.1. It is essential that you perform this conversion before taking any new data with the instrument. Instructions appear in the following section.**

CONVERTING PREVIOUS VERSION FILES TO VERSION 1.6 FORMAT

Recipes, sequences, and data generated with versions of software prior to 1.4.2 must be converted to version 1.6.1 format if you wish to make use of them. The conversion program does not destroy the original files and works for files stored on either the hard disk or on diskettes. You must convert files on the hard disk first.

To convert previous version files to 1.6.1 format:

1. Choose To DOS from the Exit menu. Type *y* to confirm that you wish to return to DOS when prompted, then press ENTER.
2. If the DOS prompt that appears is C:\TENCOR, go to Step 3. If the DOS prompt that appears is other than C:\TENCOR, type *c:* and press ENTER, then type *cd \tencor* and press ENTER again.
3. Type *convdb* and press ENTER.
4. When the conversion process is complete and the C:\TENCOR prompt returns, type *p2* (or *p2h* if your instrument has a wafer handler) and press ENTER to run the main program.
5. Press ENTER again when prompted to initialize the software.
6. Verify that the recipes, sequences, and data have been converted.

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APPENDIX C—EXPORTING DATA

INTRODUCTION

This appendix covers two ways to exchange data from the Tencor P-2 with other commercially available or custom-designed programs. The first section describes how to run the P-2 software under Microsoft Windows 3.1 in a full-sized DOS window. The first section also describes how to generate special format ASCII files that can be quickly and easily exchanged with other Windows-based applications without the need for knowing the file format. This capability is new to software version 1.5. Note that these special format files are different than the export files described in the rest of the chapter.

The remainder of this appendix defines the format of ASCII and binary data in the standard Tencor P-2 export files. The exported data cannot be manipulated directly by the receiving program. You will need to write macros that can manipulate the data into a form usable by the receiving application. Note also that only instruments with the Database Manager Option support binary data export.

EXCHANGING DATA WITH WINDOWS APPLICATIONS

This section describes running the Tencor P-2 software in a Microsoft Windows 3.1 DOS window. It is assumed that you are comfortable with Windows 3.1 and familiar with Windows terminology and concepts.

You can run the P-2 program in several ways:

- Choose Run from the Program Manager File menu and type *c:\tencor\p2* in the Run dialog box.
- Create an icon and a .PIF file for the Tencor P-2 software; the executable file is P2.EXE and is normally in the C:\TENCOR directory.
- Double-click on the file C:\TENCOR\P2.EXE in the File Manager.
- Double-click the MS-DOS icon, change directories to C:\TENCOR and type *p2* at the DOS prompt.

Press ALT + ENTER to toggle the P-2 DOS window between a full-size window and a resizable window on the desktop. Note that the Tencor P-2 program will run slowly unless it is running in a full-size DOS window.

You can use Tencor P-2 output in other applications in two ways:

- Putting a Tencor P-2 screen on the clipboard for use in another application
- Exporting scan data to another application for further analysis

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Note that the standard color choices on the Tencor P-2 screen might not be the best choices if you wish to print the results, especially on a black-and-white printer. You can experiment until you find a P-2 color scheme that works (see Section 3.12, "Setting Screen Colors," for details on how to change colors). You can also use a graphics editor such as Windows' Paintbrush to change the screen image after saving the contents of the clipboard.

To use a Tencor P-2 screen in another application:

1. When the desired screen is displayed, press PRINT SCREEN. The screen image is put on the clipboard.
2. Press ALT + ENTER to switch back to the desktop and activate the other application (for example, a word processor).
3. Paste the contents of the clipboard into the other application.

To export scan data to another application, such as a spreadsheet or database program, you first enable a setting that causes the Tencor P-2 software to save a special formatted ASCII file whenever the data screen is displayed. Then, in the other application, you import the file.

To enable the export of scan data to another application:

1. Press MENU to display the main menu bar.
2. Choose Settings from the Config menu.
3. Use the trackball or [↑] or [↓] to select the Save Data in ASCII field.
4. Press [←] or [→] to toggle the value in the field to ENABLE.
5. Press [F2: Save] to save the new settings.

With Save Data in ASCII enabled, a file by the name TEMPxx.TXT (where xx represents a two-digit number in the range 00 to 99) is saved in the C:\TENCOR\EXP\SDATA directory each time the Data screen is displayed. This file can be opened in another application.

Note that the numbering of these temporary files starts over with TEMP00.TXT each time the Tencor P-2 software is started. Be sure to periodically rename temporary files or incorporate them into other applications before the temporary files are overwritten.

Note that these TEMPxx.TXT files differ from the export files discussed in the rest of this appendix. These files are provided to allow quick and easy exchange of scan data without requiring extensive knowledge of the standard Tencor P-2 export file formats. They are not intended to replace the standard export files.

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STANDARD EXPORT FILES: AN OVERVIEW

With Tencor P-2 software version 1.1 or later, you can format data for use by other programs such as standard commercial spreadsheets and database managers. You can export data in ASCII format from any P-2, and in binary format if the Database Manager Option is installed. Data can only be imported in binary format. This rest of this appendix defines the format of ASCII and binary data in the exported files.

Records are large and sometimes variable in length. Export breaks the data records into multiple lines, enabling the records to be read by commercial programs. Note: The exported data cannot be manipulated directly by the receiving program. You will need to write macros that can manipulate the data.

You can export data manually from the Data catalog or automatically from a sequence. For details on the procedures, refer to Section 7.12, "Exporting Data," and Section 10.10.2, "Exporting Sequence Data."

MANAGING EXPORT FILES

The exported files are placed in subdirectories EXP\SDATA, EXP\SEQ, or EXP\RECIPE depending on the type of data exported (see Table C-1). These subdirectories will be in directory A:\TENCOR on drive A if you are exporting files to drive A. If you are exporting files to drive C, the subdirectories will be in the current directory on drive C. Select the drive using the disk path option. See Section 7.9, "Saving Data and Recipes," for more information on selecting disk paths.

When you export data, you can specify a filename of up to eight characters or use the default filename consisting of the first eight characters of the Data ID. The program automatically assigns the extension depending on the format and type of data exported. The following table lists the data types, formats, file extension, and the directories to which data is exported.

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Table C-1 ASCII and Binary File Extensions and Directories

File Extension	Export Directory	Data Format and Type
.QFT	EXP\SDATA	ASCII format; database manager option not installed
.RWT	EXP\SDATA	ASCII format; trace data
.SMT	EXP\SDATA	ASCII format; point data
.SQT	EXP\SDATA	ASCII format; sequence
.QFB	EXP\SDATA	Binary format; database manager option not installed
.RWB	EXP\SDATA	Binary format; raw trace
.SMB	EXP\SDATA	Binary format; summary
.SQB	EXP\SDATA	Binary format; automatic sequence data
.SEQ	EXP\SEQ	Binary format; sequence[1]
.RCP	EXP\RECIPE	Binary format; recipe[1]

[1] Sequence programs and recipes can be exported in binary format only.

Unlike data exported in ASCII format, data exported in binary format will not have line numbers or a space between two fields. The binary format export file will contain all the fields of the summary or raw data records.

DATA RECORDS FOR ASCII DATA

Data records consist of line, field, and column and width elements. Each of the elements is explained below.

Line

The export function ordinarily numbers each line of a record. The format of a line depends on its ordinal number and the record type. The first line has the same format for each record type and specifies the record type. The ordinal line numbers for each record are sequential, begin with number 1, and contain no gaps in the sequence.

> **NOTE:** **Some fields in the database might not be used every time data is stored. Such fields will not contain meaningful values when exported.**

Field

Numeric fields are left-justified and character string fields are right-justified.

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Column, Width

Column starting positions and widths shown are minimums. Data corruption can cause field widths and subsequent column starting positions to be exceeded. There is always at least one space between adjacent fields, and fields always contain some visible characters.

DATA FORMAT TABLES FOR ASCII DATA

The following tables show the format of ASCII data in each exported file. The tables include the formatting of database seven-level IDs, line 1 (which has the same format for all record types), recipe and summary data format, raw data or raw trace, and statistics (if sequence data is exported).

Database Seven-Level IDs Line Format (If Database Manager Option Installed)

If the Database Manager Option is not installed, the data in the following table will not be exported.

Table C-2 Database Seven-Level IDs Format

Line	Field	Column	Width	Description
A	1	1	3	Character, line number
A	2	5	17	id1name, character string, data ID 1 name
A	3	23	17	id2name, character string, data ID 2 name
A	4	41	17	id3name, character string, data ID 3 name
A	5	59	17	id4name, character string, data ID 4 name
B	6	1	3	Character, line number
B	7	5	17	id5name, character string, data ID 5 name
B	8	23	17	id6name, character string, data ID 6 name
B	9	41	17	id7name, character string, data ID 7 name

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Line 1 Format

This line format is common to all record types. In the case of sequence data, the data in the following table is exported before each sequence data record.

Table C-3 Line 1 Format

Line	Field	Column	Width	Description
1	1	1	3	Integer, line number (always 1)
1	2	5	1	Integer, record type, (1: point data and raw trace, 2: point data, 3: statistics)
1	3	7	17	Character string, data ID (part ID)
1	4	25	11	Character string, recipe ID
1	5	37	11	Character string, sequence ID (null if none)

Recipe Format

Table C-4 Recipe Format

Line	Field	Column	Width	Description
2	1	1	3	Integer, line number (always 2)
2	2	5	8	Hex integer, recipe creation time[1]
2	3	14	6	Integer, scan length in microns
2	4	21	3	Integer, scan speed code (0: 1 µm/s, 1: 2 µm/s, 2: 5 µm/s, 3: 10 µm/s, 4: 20 µm/s, 5: 50 µm/s, 6: 100 µm/s, 7: 200 µm/s, 8: 400 µm/s, 9: 1 mm/s, 10: 2 mm/s, 11: 5 mm/s, 12: 10 mm/s, 13: 25 mm/s)
2	5	25	3	Integer, stylus drop speed code

[1] Time is formatted as a hexadecimal integer, representing the number of seconds since 12:00 a.m., January 1, 1970. This is standard Unix-C time format and can be used as input to standard C library functions for time manipulation (for example, local time ( )). Versions 1.1 and 1.2 use local time only and do not correct for time zone.

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Table C-4 Recipe Format (continued)

Line	Field	Column	Width	Description
2	6	29	5	Integer, stylus radius required in tenths of microns
2	7	35	1	Integer, scan direction (0: L to R, 1: R to L)
2	8	37	3	Integer, repeat count
2	9	41	1	Integer, profile code (0: mean, 1: peak, 2: valley)[2]
2	10	43	3	Integer, vertical range (0: 300 μm, 1: 13 μm)[3]
2	11	47	5	Integer, stylus force in tenths of milligrams
2	12	53	1	Sampling Rate Code (0: 50 Hz, 1: 100 Hz, 2: 200 Hz)
2	12	55	3	Integer, vertical display range code[4]

[2] Trace display code: (300 μm range only)

1=  center bias

2=  peak bias

3=  valley

[3] Vertical range code:
0 = 300 μm range, 25Å resolution (12 mil range, 1 min resolution)
1 = 13 μm range, 1Å resolution (520 μin. range, .004 μin. resolution)

[4] Vertical display range code:
0: auto, 1: 100Å/.4 μin., 2: 160Å/.65 μin., 3: 250Å/1 μin., 4: 400Å/1.6 μin., 5: 650Å/2.5 μin., 6: .1 μin./4 μin., 7: .16 μin./6.5 μin., 8: .25 μin./10 μin., 9: .40 μin./16 μin., 10: .65 μin./25 μin., 11: 1.0 μin./40 μin., 12: 1.6 μin./65 μin., 13: 2.5 μin./100 μin., 14: 4.0 μin./250 μin., 15: 6.5 μin./250 μin., 16: 10 μin./400 μin., 17: 16 μin./650 μin., 18: 25 μin./1 mil, 19: 40 μin./1.6 mil, 20: 65 μin./25 mil, 21: 100 μin./400 mil, 22: 160 μin./6.5 mil, 23: 250 μin./10 mil, 24: 400 μin./16 mil.

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Table C-4 Recipe Format (continued)

Line	Field	Column	Width	Description
2	13	59	1	Integer, trace display code[5]
2	14	61	1	Integer, filter cutoff code (See "Format Notes" later in this chapter)
2	15	63	1	Integer, horizontal units code (0: μm, 1: mm, 2: mil)
2	16	65	2	Integer, number of scan segments (0: 1 seg)
2	17	68	6	Integer, intersegment spacing (undefined if not a segmented scan)
2	18	75	5	Integer, recipe version number
3	1	1	3	Integer, line number (always 3)
3	2	5	2	Integer, recipe type 3-D or 2-D
3	3	8	3	Integer, number of traces in 3-D scan
3	4	12	2	Integer, y_spacing (for 3-D, 0 for 2-D)
3	5	15	2	Integer, rotation amount (for 3-D, 0 for 2-D)
3	6	18	2	Integer, color banding (for 3-D, 0 for 2-D)
3	7	21	1	Insigned character, y_level front (3-D y leveling)
3	8	23	1	Unsigned character, (range 1 to 255; 0 is invalid)

[5] Trace display code:
0: raw data, 1: raw data + roughness, 2: raw data + waviness, 3: all, 4: roughness, 5: waviness, 6: roughness + wave.

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Summary Data Format

Table C-5 Summary Data Format

Line	Field	Column	Width	Description
4	1	1	3	Integer, line (always 4)
4	2	5	3	Integer, location number (defined for sequence scans, range 0 to 199)
4	2	9	3	Integer, number of 3-D traces (if 3-D else 0)
4	2	13	1	Insigned character, y_level front (3-D y leveling)
4	2	15	1	Unsigned character, y_level back (range 1 to 255; 0 is invalid)
4	2	17	8	Integer, time scan was taken
4	2	26	6	Integer, scan X coordinate (in microns)
4	2	33	6	Integer, scan Y coordinate (in microns)
4	2	40	8	Integer, scan theta coordinate
4	2	49	8	Integer, left level cursor position
4	2	58	8	Integer, right cursor position
4	2	67	8	Integer, left measurement cursor position
4	2	76	8	Integer, right measurement cursor position
4	2	85	8	Integer, left measurement delta average cursor position
4	2	94	8	Integer, right measurement delta average cursor position
4	2	103	8	Integer, left level delta average cursor position
4	2	112	8	Integer, right level delta average cursor position
4	2	121	1	Integer, range error flag (1: range exceeded)
4	2	123	1	Integer, display units code (0: angstrom, 1: microinches)
4	2	125	9	Integer, measured height at left cursor
4	2	135	9	Integer, measured height at right cursor
5, 6	1	1	3	Integer, line number (5 or 6)
5, 6	2	5	5	Integer, parameter code (see "Parameter Codes" at the end of this chapter)

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Table C-5 Summary Data Format (continued)

Line	Field	Column	Width	Description
5, 6	3	11	11	Float, parameter value in angstrom truncated to tenths of angstrom
5, 6, 5	-	-	-	There are 10 parameters per line for a total of 20 and a line length of 173 characters.
-	-	-	-	Point data lines 7 and following for record type 2 (+ raw trace) only
7	1	1	3	Line numbers
7	2	5	9	Long, ddd, minimum 2 (for 3-D raw data file)
7	3	15	9	Long, ddd, maximum 2 (for 3-D raw data file)

Raw Data or Raw Trace

Point data lines 7 and following apply to the record type 2 [+ raw trace] only.

Table C-6 Raw Data or Raw Trace Format

Line	Field	Column	Width	Description
8	1	1	3	Integer, line number (always 8)
8	2	5	6	Integer, number of data points in raw trace
8	3	11	10	Float, gain
8	4	22	10	Float, horizontal resolution in microns
8	5	33	8	Long, analog filter cutoff wavelength in hundreds of microns
8	6	42	3	Unsigned character, trace number of 3-D scan (0 if 2-D scan)
8	7	46	3	Unsigned character, trace offset of current 3-D scan (0 if 2-D scan)
9	1	1	3	Integer, line number (range 9 to 323)
9..	2..	5..	9	Integer, raw trace point value, maximum 20 per line (in ADC counts multiply by gain to get result in angstrom)

For 3-D scans, the line number will be successively increased from 8 until all the traces in each 3-D scan are written (all data points in each trace).

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Statistics Format

Table C-7 Statistics Format

Line	Field	Column	Width	Description
2	1	1	3	Integer, line number (always 2)
2	2	5	8	Hex integer, time of earliest scan[1]
2	3	14	8	Hex integer, time of latest scan[1]
2	4	23	1	Integer, display units code (0: angstroms, 1: microinches)
3-22	1	1	3	Integer, line number (range 3 to 22)
3-22	2	5	5	Integer, parameter code
3-22	3	11	5	Integer, number of statistical samples (N)
3-22	4	17	10	Float, mean in angstroms
3-22	5	28	10	Float, standard deviation in angstroms
3-22	6	39	10	Float, minimum value in angstroms
3-22	7	50	10	Float, maximum value in angstroms

[1] Time is formatted as a hexadecimal integer, representing the number of seconds since 12:00 a.m., January 1, 1970. This is standard Unix-C time format and can be used as input to standard C library functions for time manipulation (for example, local time ( )). Versions 1.1 and 1.2 use local time only and do not correct for time zone.

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DATA FORMAT TABLES FOR BINARY DATA

> **NOTE:** Binary data can only be imported and exported on instruments with the Database Manager Option.

The following data format tables show the format of the binary data in each exported file. The tables include the format of database seven-level IDs line format, recipe and summary data format, statistics format, and sequence program format.

Database Seven-Level IDs Record Format

Table C-8 Database Seven-Level IDs Record Format

Field	Type	Offset	Size	Description
id1name	string	0	18	Data ID 1 name
id2name	string	18	18	Data ID 2 name
id3name	string	36	18	Data ID 3 name
id4name	string	54	18	Data ID 4 name
id5name	string	72	18	Data ID 5 name
id6name	string	90	18	Data ID 6 name
id7name	string	108	18	Data ID 7 name
–	–	126	10	Space reserved for internal information

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Recipe Format

For single scans, Recipe data starts immediately after the IDs in the file, embedded in Summary and Raw Data records.

Table C-9 Recipe Format

Field	Type	Offset	Size	Description
rcp_code	int	12	2	Reserved for future code word key
create_time	long int	14	4	Time of last recipe update[1]
sc_leng	long int	18	4	Scan length in 0.01 μm
sc_speed	enum	22	1	Scan speed selection
sty_drop_spd	enum	23	1	Speed of stylus drop, 0...9 for 1...10
sty_radius	int	24	2	Specified stylus radius
sc_dir	enum	26	1	Scan direction:0 = -> 1 = <-
rep_count	int	27	1	Repeat count for multi-scan average
profile	enum	28	1	Profile type[2]
vert_range	enum	29	1	vertical range: 0 = hi 1 = lo 2 = medium
sty_force	int	30	2	Stylus force in 0.1 mg
p_units	enum	32	1	Vertical display units:0 = metric 1 = English
Srate	enum	33	1	Sampling rate: 0 = 50 Hz 1 = 100 Hz 2 = 200 Hz

1 Time is formatted as a hexadecimal integer, representing the number of seconds since 12:00 a.m., January 1, 1970. This is standard Unix-C time format and can be used as input to standard C library functions for time manipulation (for example, local time ( )). Versions 1.1 and 1.2 use local time only and do not correct for time zone.

2 Trace display code: (300 μm range only)

0=  center bias

1=  peak bias

2=  valley

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Table C-9 Recipe Format (continued)

Field	Type	Offset	Size	Description
(cursors)				
lvlcr_l	long int	34	4	Left leveling cursor position in 0.01 μm
lvlcr_r	long int	38	4	Right leveling cursor position in 0.01 μm
meacr_l	long int	42	4	Left measurement cursor position in 0.01 μm
meacr_r	long int	46	4	Right measurement cursor position in 0.01 μm
mdav_l	long int	50	4	Left delta-average measurement cursor position in 0.01 μm
mdav_r	long int	54	4	Right delta-average measurement cursor position in 0.01 μm
ldav_l	long int	58	4	Left delta-average leveling cursor position in 0.01 μm
ldav_r	long int	62	4	Right delta-average leveling cursor position in 0.01 μm
segment_sw	enum	66	1	Segmentation switch:0 = off 1 = on
v_disp_range	enum	67	1	Vertical display range for new scan
disp_trace	enum	68	1	Select trace displayed (3-D)
wcutoff	enum	69	1	Longwave filter selection[3]
l_units	enum	70	1	Horizontal display units:0 = μm 1 = mm 2 = English
segment	int	71	1	Number of scan segments
space_len	int	72	4	Segment gap in 0.01 μm
ncutoff	enum	76	1	Noise filter selection[4]

[3]Longwave filter cutoff values:
0: Off; 1: 4.5 μm; 2: 8 μm; 3: 14 μm; 4: 25 μm; 5: 45 μm; 6: 80 μm; 7: 140 μm; 8: 250 μm; 9: 450 μm; 10: 800 μm; 11: 1.4 mm; 12: 2.5 mm; 13: 4.5 mm; 14: 8 mm; 15: 14 mm; 16: 25 mm

[4]Noise filter cutoff values:
0: Default; 1: 0.25 μm; 2: 0.45 μm; 3: 0.8 μm; 4: 1.4 μm; 5: 2.5 μm; 6: 4.5 μm; 7: 8 μm; 9: 25 μm; 10: 45 μm; 11: 80 μm; 12: 140 μm; 13: 250 μm; 14: 450 μm; 15: 800 μm; 16: 1.4 mm; 17: 2.5 mm; 18: 4.5 mm; 19: 8 mm; 20: 14 mm; 22: 25 mm

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Table C-9 Recipe Format (continued)

Field	Type	Offset	Size	Description
op1s_type	enum	77	1	Curve fit and level:0 = off 1 = on
(3-D Extensions)				
recipe_type	enum	78	1	Recipe type: 0 = 2-D 1 = 3-D
num_traces	int	79	1	Number of y traces
y_spacing	int	80	4	Spacing between y traces in 0.01 μm
rotation_amount	enum	84	1	View angle[5]
color_banding	enum	85	1	Height colors: 0 = on 1 = off
YLevFront	int	86	1	Y leveling, front trace number
YLevBack	int	87	1	Y leveling, back trace number
version	int	88	2	Recipe version (for example, 16 for Version 1.6)
p_descr[20]	int	90	2*20	Parameter descriptions[5]

[5]Parameter descriptors (bitfields):

Main descriptor: FDSm mmmm pppp pppp

- F: Failed flag, used only in data records
- D: Display flag, highest display priority
- S: Save/calculate flag, calculates with lower display priority
- m: Modifier field, meaning varies with parameter
- p: Parameter selection (see below)

Extended modifier: 000r rrvv vvvv vvvv

- r: Range field, meaning varies with parameter
- v: Value field, meaning varies with parameter

In Recipe for Versions 1.6 and preceding, the first parameter is always Step Height. This parameter is always calculated and displayed whether or not the Display or Save flag bits are set in the recipe descriptor.

Stress parameter descriptors:

Descriptors for Stress parameters are a special case. Their lower eight bits (selector field) are identical to some other parameters, but they have a modifier field value of 4 hexadecimal (that is, adding 400 hexadecimal or 1024 to the selector field). In all versions up to and including version 1.6, stress parameters are not used in recipe descriptors, but only in summary descriptors.

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Table C-10 Surface Parameter Table

Num	Description	Modifier	Units
1	Step Height	None	Angstroms
2	Ra	None	Angstroms
3	MaxRa	None	Angstroms
4	Rq	None	Angstroms
5	Rp	None	Angstroms
6	Rv	None	Angstroms
7	Rt	None	Angstroms
8	Rz	None	Angstroms
9	R3z	None	Angstroms
10	Wa	None	Angstroms
11	Wq	None	Angstroms
12	Wp	None	Angstroms
13	Wv	None	Angstroms
14	Wt	None	Angstroms
15	TIR	None	Angstroms
16	Average Height	None	Angstroms
17	Slope	None	Degrees
18	Radius	None	Angstroms
19	Area mid-to-peak	None	Square angstroms
20	Area mid-to-valley	None	Square angstroms
21	Area base-to-peak	None	Square angstroms
22	Profile length	None	Angstroms
23	Rpm	None	Angstroms
24	Dq	None	None
25	Lq	None	Angstroms
26	SD, standard deviation of height	None	Angstroms
27	Pc, peak count (density)	Height Band	Count per angstrom
28	HSC, high spot count (density)	Height	Count per angstrom

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Table C-10 Surface Parameter Table (continued)

Num	Decription	Modifier	Units
29	Sm, mean peak spacing	Height Band	Angstroms
30	tp, bearing ratio at depth	Depth	None
31	CD, cutting depth at bearing ratio	Percent	Angstroms
32	Edge	None	Angstroms
33	Width	None	Angstroms
34	Step height on roughness trace	None	Angstroms
35	Step height on waviness trace	None	Angstroms

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Summary Data Format

Table C-11 Summary Data Format

Field	Type	Offset	Size	Description
datamenu	Recipe	0	130	See Recipe Format, Table C-9
d_id[18]	string	130	18	Data ID (ID7 for Database)
sdata_code	int	148	2	Reserved for future code key
version	int	150	2	Software version (for example, 16 for V1.6)
location	int	152	2	Sequence location number
TotalTraces	int	154	1	3_D tota traces
YLevFront	int	155	1	3_D leveling front trace number
YLevBack	int	156	1	3-D leveling back trace number
reserve1[1]	–	157	1	Space reserved
sum_time	long	158	4	Scan date and time, Unix-style
dxcoord	long	162	4	X stage coordinate in μm
dycoord	long	166	4	Y stage coordinate in μm
dtheta	long	170	4	Theta stage coordinate in raw encoder counts
dlvlcr_l	long	174	4	Left leveling cursor position in 0.01 μm
dlvlcr_r	long	178	4	Right leveling cursor position in 0.01 μm
dmeacr_l	long	182	4	Left measurement cursor position in 0.01 μm
dmeacr_r	long	186	4	Right measurement cursor position in 0.01 μm
dmdav_l	long	190	4	Left delta-average measurement cursor position in 0.01 μm
dmdav_r	long	194	4	Right delta-average measurement cursor position in 0.01 μm
dldav_l	long	198	4	Left delta-average leveling cursor position in 0.01 μm
dldav_r	long	202	4	Right delta-average leveling cursor position in 0.01 μm

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Table C-11 Summary Data Format (continued)

Field	Type	Offset	Size	Description
range_err	flag	206	1	Data out of range flag
sum_p_units	enum	207	1	Vertical display units:0 = metric 1 = English
dmht_l	long	208	4	Height at left measuring cursor in Angstroms
dmht_r	long	212	4	Height at right measuring cursor in Angstroms
param[20]	PARAM_ITEM	216	6*20	Parameter results (see Table C-12)
ddd_min_z	long	336	4	3-D minimum height in ADC counts
ddd_max_z	long	340	4	3-D maximum height in ADC counts
radius_cal	float	344	4	Radius calibration factor
reserve2[6]	–	348	6	Space reserved

Table C-12 PARAM_ITEM: Parameter Result Item Format

Field	Type	Offset	Size	Description
s_desc	bitfield	0	2	Descriptor (see Table C-9, footnote 4)
s_value	float	2	4	Value, units depend on descriptor (see Table C-9, footnote 4)

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Raw Data

Table C-13 Raw Data Format

Field	Type	Offset	Size	Description
rsdata	Summary[1]	0	354	
raw_size	int	354	2	Current trace size in number of data points
r_update	flag	356	2	Used to indicate need for display update
dgainx	float	358	4	Gain factor for raw data
horiz_res	float	362	4	Horizontal resolution in μm
range_err	flag	366	1	Data out of range flag
data_type	enum	367	1	Scan type: 0 = 2-D 1 = 3-D
analog_cutoff	int	368	4	Analog cutoff value in 0.01 μm
reserve[2]	–	372	2	Space reserved
TraceNumber	int	374	2	3-D trace number of this trace
TraceOffset	int	376	2	3-D data starting point offset in number of data points
mod[0...6301]	int	378	4*size	Raw data in ADC counts

[1] If 3-D data is being exported, the RAW_DATA structure will be exported for each trace. SUM_DATA, however, will be exported only once because SUM_DATA remains the same for all the traces. The 3-D data in the export file will be exported in the order displayed below:

1. Database Seven IDs
2. Summary data
3. Raw data for scan 1 (from field number 2 onwards)
4. Raw data for scan 2 (from field number 2 onwards)
5. Raw data for scan 3 (from field number 2 onwards)

... and so forth.

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Sequence Program Format

Table C-14 Sequence Program Format

Field	Type	Offset	Size	Description
version	int	0	2	Software version (for example, 16 for V1.6)
id	string	2	14	Sequence ID
comment1	string	16	28	Comment field 1
comment2	string	44	38	Comment field 2
data_id1	string	82	18	id 1 value for data storage
data_id2	string	100	18	id 2 value for data storage
data_id3	string	118	18	id 3 value for data storage
mode	enum	136	1	Sequence mode:0 = auto 1 = manual 2 = setup
deskew	enum	137	1	Deskew: 0 = on 1 = off
type	enum	138	1	Sequence type:0 = random 1 = circular
print	enum	139	1	Print: 0 = no 1 = yes
prt_stat	enum	140	1	prt_stat: 1 = print statistic
save	enum	141	1	save: 0 = not data 1 = statistics 2 = point data 3= raw data
export	enum	142	1	same as save
sort	enum	143	1	Sort option :0 = off 1 = on
wd	int	144	2	Wafer diameter (handler)
wo[6]	string	146	6	Wafer orientation (handler)
ws[6]	string	152	6	Wafer selection (handler)

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Table C-14 Sequence Program Format (continued)

Field	Type	Offset	Size	Description
rcp_id	string	158	14	ID for uniform type (unused)
exclusion_in	int	172	2	Uniform map exclusion (unused)
exclusion_out	int	174	2	Uniform map exclusion outside (unused)
no_point	int	176	2	Uniform map number of points (unused)
sort_rcp	SORT_RCP	178	344	Array of sort recipes (see Table C-15 for format)
sort_prt	int	522	2	sort_prt: 0 = don't care 1 = pass 2 = fail
sort_save	int	524	2	Same as sort_prt
sort_pass_loc	int	526	2	Location to put passed wafer
sort_fail_loc	int	528	2	Location to put failed wafer
sort_prt_spec	int	530	2	No/yes print sort specification
pos_deskew	STAGE_POS	532	36	Deskew stage positions (2 used) (See Table C-17 for format)
wfr_cass_mode	int	568	2	Wafer cassette mode:0 = disable 1 = select 2 = random
wfr_ld_src	int	570	2	Wafer load source
wfr_unld_dest	int	572	2	Wafer unload destination
wfr_num_rand	int	574	2	Number of random wafers to select
wfr_align_feature	int	576	2	Wafer feature to align or disable
wfr_align_angle	float	578	4	Angle to align wafer
wfr_cass_bitmap	long	582	4	Cassette wafer process map (bit 0==1 -> process slot 1)
sort_p_units	flag	586	1	Bitwise units rcp # [xxxx4321] 0 = metric 1= English
sort_fail_pause	enum	587	1	Pause if sort fail:0 = no 1 = yes
size	int	588	2	Number of locations (scans)
item[1...300]	SEQ_P	590	size*26	Recipe and location of scan (See Table C-18 for format)

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Table C-15 SORT_RCP: Sort Recipe Format

Field	Type	Offset	Size	Description
rcp_id	string	0	14	Name of the recipe
param[2]	SORT_PARAM	14	72	2 parameters (See Table C-16 for format)

Table C-16 SORT_PARAM: Sort Parameter Format

Field	Type	Offset	Size	Description
id	int	0	2	Parameter ID from recipe
x_ena	enum	2	1	Enable mean: 0 = deselect 1 = select
sd_ena	enum	3	1	Enable standard deviation:0 =deselect 1 = select
r_ena	enum	4	1	Enable range: 0 = deselect 1 = select
ol_ena	enum	5	1	Enable outlier:0 = deselect 1 = select
x_min	float	6	4	Minimum mean to pass
x_max	float	10	4	Maximum mean to pass
sd_max	float	14	4	Maximum standard deviation to pass
r_min	float	18	4	Range, minimum parameter value to pass
r_max	float	22	4	Range, maximum parameter value to pass
ol_min	float	26	4	Outlier, minimum parameter value to pass
ol_max	float	30	4	Outlier, maximum parameter value to pass
ol_pass_pct	int	34	2	Percent that must pass outlier test

Table C-17 STAGE_POS: Stage Position Format

Field	Type	Offset	Size	Description
x	long	0	4	X coordinate in μm
y	long	4	4	Y coordinate in μm
theta	long	8	4	Theta coordinate in encoder counts

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Table C-18 SEQ_P: Sequence Location Format

Field	Type	Offset	Size	Description
rcp_id	string	0	14	Recipe ID used for scan
x	long	14	4	X coordinate in μm
y	long	18	4	Y coordinate in μm
theta	long	22	4	Theta coordinate in encoder counts

Sequence Results Format

Sequence Results binary export files are built up from collections of smaller components. Each starts with a 136-byte-long database ID record, followed by the Sequence program, which has variable length depending on the number of locations in the sequence.

Following the Sequence program are data components of various types and lengths. Each such component contains a one-byte tag describing the type, followed by the data record. Only the Statistics data record is unique to the sequence results; the other types, raw data and summary (or point) data, are the same as previously described.

Sequence Results Format

- Sequence Data IDs
- Sequence Program
- Sequence Data Component [1...]

Table C-19 Sequence Data Component Format

Field	Type	Offset	Size	Description
SeqDataType	enum	0	1	Sequence data type tag:4 = Statistics 5 = Summary Data 6 = Raw Data
DataRecord	???	1	?	Data component specified by type tag: Statistics, Summary or Raw

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Statistics Format

Table C-20 Statistics Format

Field	Type	Offset	Size	Description
stat_id_code	string	0	12	Recipe ID of included scans
stat_type	int	12	2	Used as sorting code:-1
stat_end_time	int	14	4	Time of latest included scan
stat_begin_time	int	18	4	Time of earliest included scan
stat_param[20]	STAT_PARAM	22	20*20	Parameter statistics (See Table C-21 for format)
stat_p_units	enum	422	1	Display units: 0 = metric 1 = English
reserved space	–	423	45	Reserved for future use

Table C-21 STAT_PARAM: Statistics Parameter Format

Field	Type	Offset	Size	Description
stat_desc	bitfield	0	12	Descriptor (see Recipe)
stat_nsamples	int	2	2	Number of included samples
stat_mean	float	4	4	Mean value of included samples
stat_stdev	float	8	4	Standard deviation
stat_min	float	12	4	Minimum value of included samples
stat_max	float	16	4	Maximum value of included samples

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FORMAT NOTES

- The table below lists the differing cutoff filter length codes for software versions 1.1 and for later versions.

Table C-22 Cutoff Filter Length Codes

Version 1.1		All Later Versions	
Code	Cutoff (mm)	Code	Cutoff (mm)
0	filter off	0	filter off
1	0.008	1	0.0045
2	0.025	2	0.008
3	0.08	3	0.014
4	0.25	4	0.025
5	0.8	5	0.045
6	2.5	6	0.08
7	8	7	0.14
8	25	8	0.25
–	–	9	0.45
–	–	10	0.8
–	–	11	1.4
–	–	12	2.5
–	–	13	4.5
–	–	14	8.0
–	–	15	14.0
–	–	16	25.0

- All values are metric unless otherwise indicated. Horizontal values are in microns and cursor positions are in tenths of microns. Vertical measurement values are in angstroms.
- English/metric display code flags refer to the display mode only and do not describe the units in the data fields.

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APPENDIX D—PRECISION LOCATORS

Precision locators are fixtures that allow you to exactly position a sample relative to a fixed reference point. Tencor Instruments provides three types of precision locators:

- *Standard Precision Locators* (for instruments shipped after Dec. 1992): Instruments are shipped with one of the locators in this list. These locators are designed for use on instruments with the new-style lightweight stage. Note: These locators *cannot* be used on older instruments (those shipped before December 1992, serial numbers below 216).
- *Standard Precision Locators* (for instruments shipped prior to Dec. 1992): Instruments were formerly shipped with one of the locators in this list. These locators can also be used on instruments with the new-style lightweight stage.
- *Optional Precision Locators*: This list includes locators for the wafer stress software and the 8-in. and the 9-in. disks. These locators mount onto the old- or new-style stage tables. Note: These locators have to be purchased separately.

Note: The vacuum chuck is supplied with instruments that have the wafer handler option.

The following sections list the available locators and also provide graphic representations of the locators. See Appendix E, "Ordering Information," for model numbers to order locators.

STANDARD PRECISION LOCATORS (Instruments Shipped After 12/92)

Standard precision locators for instruments shipped December 1992 and after (serial number 216 and above) include:

4-in. for Wafer with Flat/Square Substrate
4-in. for Wafer with Notch
5-in. for Wafer with Flat/Square Substrate
5-in. for Wafer with Notch
6-in. for Wafer with Flat/Square Substrate
6-in. for Wafer with Notch
8-in. for Wafer with Notch

STANDARD PRECISION LOCATORS (Instruments Shipped Before 12/92)

Standard precision locators for instruments shipped prior to December 1992 (serial number below 216) include:

2-in. for Wafer with Flat/Square Substrate
3-in. for Wafer with Flat/Square Substrate
82-mm for Wafer with Notch

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4-in. for Wafer with Flat/Square Substrate
5-in. for Wafer with Flat/Square Substrate
5-in. for Wafer with Notch
8-in. for Wafer with Notch
8-in. for Wafer with Flat/Square Substrate
48-mm for Disk, 12 mm ID
65-mm for Disk, 20 mm ID
95-mm for Disk, 25 mm ID
130-mm for Disk, 40 mm ID

OPTIONAL PRECISION LOCATORS

Note: One of the optional precision locators is provided with the wafer stress software used to determine the amount of stress that a deposited film induces in a substrate.

2-in. Wafer Stress for Wafer with Flat/Square Substrate
3-in. Wafer Stress for Wafer with Flat/Square Substrate
4-in. Wafer Stress for Wafer with Flat/Square Substrate
5-in. Wafer Stress for Wafer with Flat/Square Substrate
5-in. Wafer Stress for Wafer with Notch
6-in. Wafer Stress for Wafer with Flat/Square Substrate
8-in. Wafer Stress for Wafer with Flat/Square Substrate
8-in. Wafer Stress for Wafer with Notch
8-in. for Disk, 100 mm ID
9-in. for Disk, 100 mm ID

NOTE: **Standard precision locators for instruments shipped December 1992 and after (serial number 216 and above) mount directly to a redesigned lightweight stage, rather than on top of the stage table as in the former design. These locators *cannot* be used on older instruments. Standard precision locators for instruments shipped before December 1992 (serial numbers below 216) can be used on newer instruments. Wafer stress and disk precision locators can be used on all instruments. See Section 2.2.6, "Installing a Precision Locator," for details.**

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STANDARD PRECISION LOCATORS

For instruments shipped December 1992 and after (serial number 216 and above).

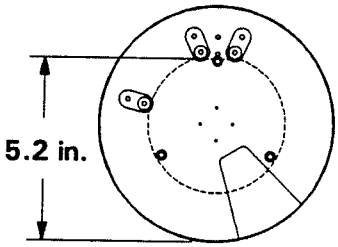


Figure D-1 Locator for 4-in. Wafer with Flat or Square Substrate

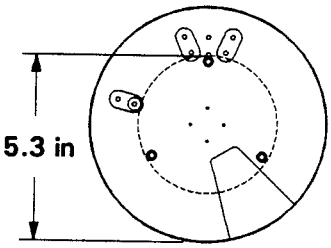


Figure D-2 Locator for 4-in. Wafer with Notch

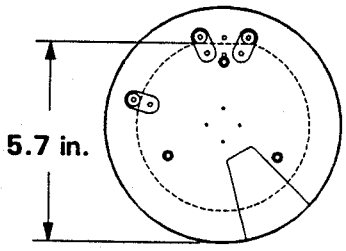


Figure D-3 Locator for 5-in. Wafer with Flat or Square Substrate

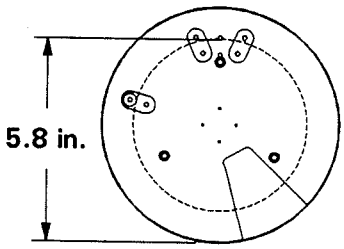


Figure D-4 Locator for 5-in. Wafer with Notch

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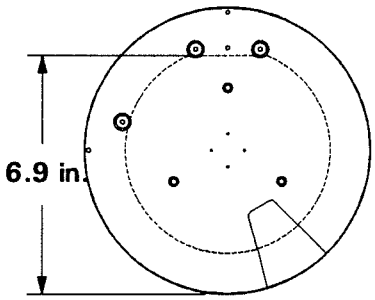


Figure D-5 Locator for 6-in. Wafer with Flat or Square Substrate

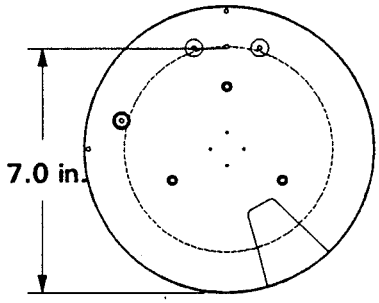


Figure D-6 Locator for 6-in. Wafer with Notch

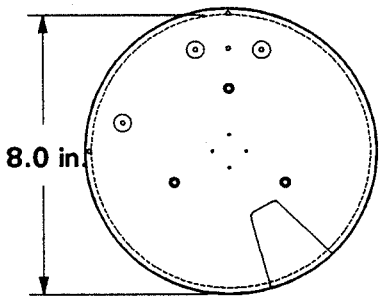


Figure D-7 Locator for 8-in. Wafer with Notch

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STANDARD PRECISION LOCATORS

For instruments shipped before December 1992 (serial numbers below 216).

WAFER STRESS PRECISION LOCATORS

For all instruments.

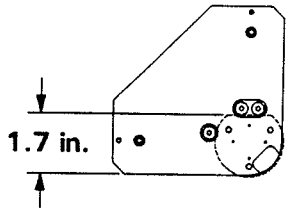


Figure D-8 Locator for 2-in. Wafer with Flat or Square Substrate

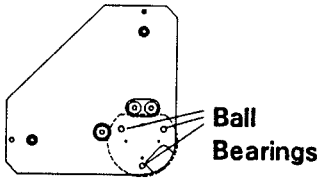


Figure D-9 Wafer Stress Locator for 2-in. Wafer with Flat or Square Substrate

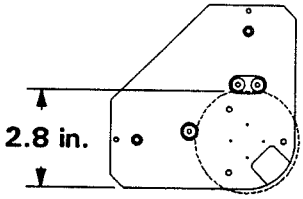


Figure D-10 Locator for 3-in. Wafer with Flat or Square Substrate

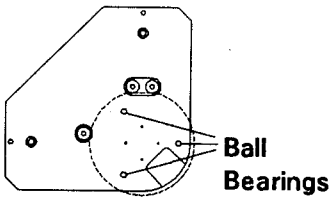


Figure D-11 Wafer Stress Locator for 3-in. Wafer with Flat or Square Substrate

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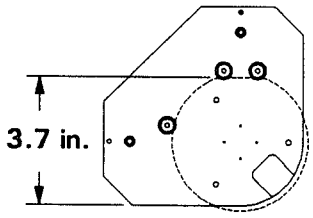


Figure D-12 Locator for 4-in. Wafer with Flat or Square Substrate

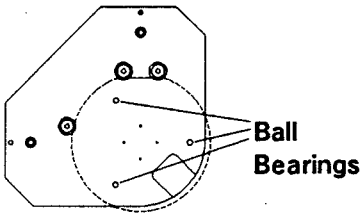


Figure D-13 Wafer Stress Locator for 4-in. Wafer with Flat or Square Substrate

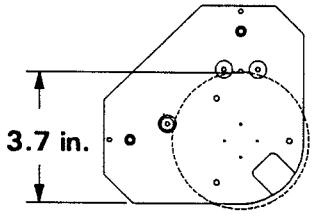


Figure D-14 Locator for 4-in. Wafer with Notch

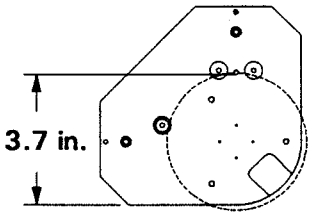


Figure D-15 Wafer Stress Locator for 4-in. Wafer with Notch

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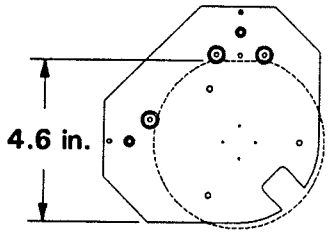


Figure D-16 Locator for 5-in. Wafer with Flat or Square Substrate

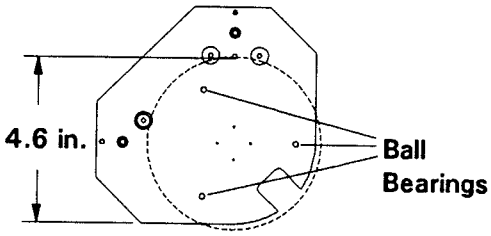


Figure D-17 Wafer Stress Locator for 5-in. Wafer with Flat or Square Substrate

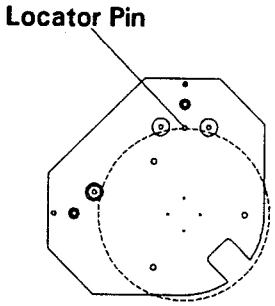


Figure D-18 Locator for 5-in. Wafer with Notch

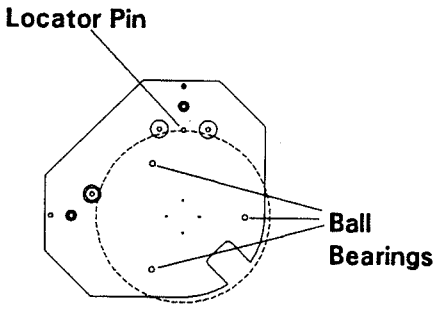


Figure D-19 Wafer Stress Locator for 5-in. Wafer with Notch

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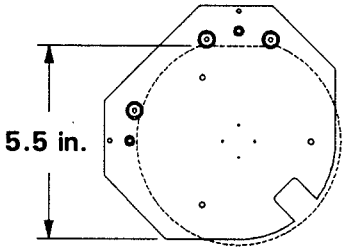


Figure D-20 Locator for 6-in. Wafer with Flat or Square Substrate

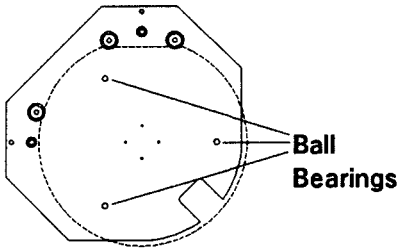


Figure D-21 Wafer Stress Locator for 6-in. Wafer with Flat or Square Substrate

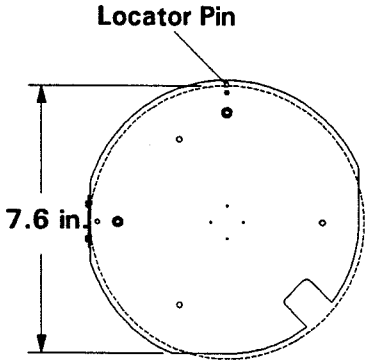


Figure D-22 Locator for 8-in. Wafer with Notch

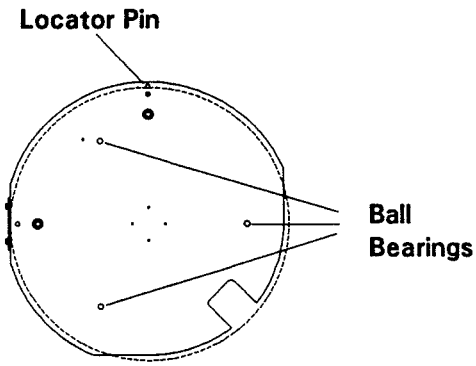


Figure D-23 Wafer Stress Locator for 8-in. Wafer with Notch

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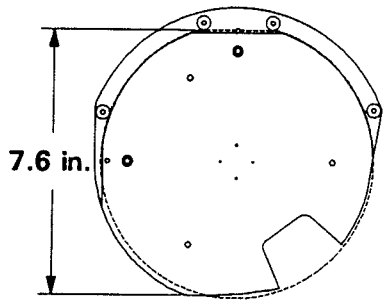


Figure D-24 Locator for 8-in. Wafer with Flat or Square Substrate

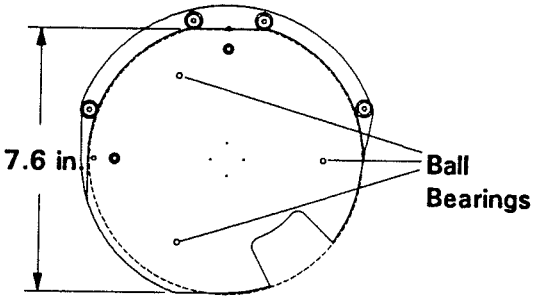


Figure D-25 Wafer Stress Locator for 8-in. Wafer with Flat or Square Substrate

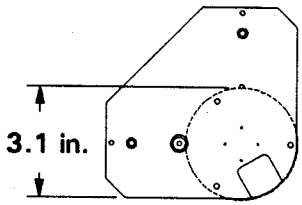


Figure D-26 Locator for 82-mm Wafer with Notch

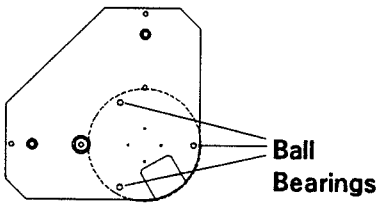


Figure D-27 Wafer Stress Locator for 82-mm Wafer with Notch

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DISK PRECISION LOCATORS

For all instruments.



Figure D-28 2.5-in. Disc Locator

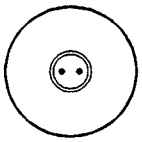


Figure D-29 3.5-in. Disc Locator

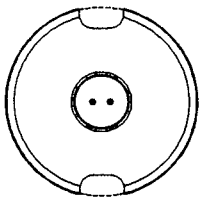


Figure D-30 5.25-in. Disc Locator

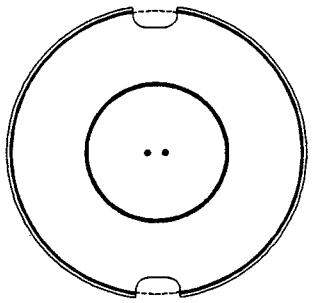


Figure D-31 8-in. Disc Locator

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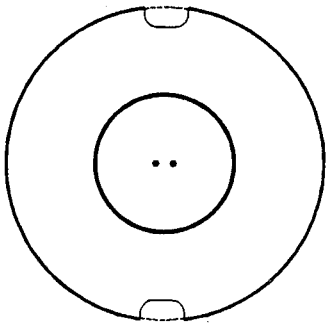


Figure D-32 9-in. Disc Locator

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APPENDIX E—ORDERING INFORMATION

SOFTWARE OPTIONS

PART NO.	DESCRIPTION
168980	Sequence/Database Manager software and remote computer keyboard
191930	Sort/Combined Statistics Option
236977	Interactive 3-D Software Option, field installed (installation not included). Includes: 387 coprocessor and 2 MB of RAM (for total of 4 MB)
196878	Offline P-2 Program and remote computer keyboard. (Note: Includes all software options.)
217883	Additional Surface Roughness Parameters Option
238180	SECS II Protocol Software Option with bi-directional communications of recipes and Sequence programs
	Wafer Stress Package, includes software and 1 wafer precision locator:
156639	2-in. for Wafer with Flat/Square Substrate
143022	3-in. for Wafer with Flat/Square Substrate
138754	4-in. for Wafer with Flat/Square Substrate
138746	5-in. for Wafer with Flat/Square Substrate
143995	5-in. for Wafer with Notch
138762	6-in. for Wafer with Flat/Square Substrate
138738	8-in. for Wafer with Notch
184284	8-in. for Wafer with Flat/Square Substrate

HARDWARE OPTIONS

217034	MicroHead Low Moment Measuring head, field installed
254509	Extended Range MicroHead, field installed
206776	Motorized Level and Rotation, factory installed, includes: Two motors with encoders, control and driver, boards, software, and Motorized Rotary Stage
222119	Exchangeable Measurement Head Assembly with High Magnification Optics (150–600X)

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R222119	Refurbished Exchangeable Measurement Head Assembly with High Magnification Optics (150–600X)
222102	Exchangeable Measurement Head Assembly with Low Magnification Optics (60–240X). Note: Can be substituted for high magnification at no charge with original order.
R222102	Refurbished Exchangeable Measurement Head Assembly with Low Magnification Optics (60–240X).
193780	Wafer Handler System, table mount, accommodates wafers up to 200 mm, single or dual cassettes
193780F	Wafer Handler System, floor mount, accommodates wafers up to 200 mm, single or dual cassettes

ACCESSORIES

129909	Printer, black and white, with original manufacturer's warranty, 110V (USA only)
129917	Printer, Color, with original manufacturer's warranty (Note: Not recommended for clean room.)
097683	Remote computer keyboard, with mounting brackets, key template
183377	Tencor P-2 User Manual
183377-27	Tencor P-2 Clean Room User Manual
188948	Reference Drawings Package
188948-27	Reference Drawings Package, Clean Room
151092	Recommended User Spares Kit
215937	Stylus to Cross Hair Alignment Tool
205958	Stylus Radius Measurement Tool
149780	Intel 80387 Math Coprocessor, 16-33 MHz
169030	RAM Memory Module, 256 KB SIP
177717	RAM Memory Module, 1 MB SIMM

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PRECISION LOCATORS

STANDARD PRECISION LOCATORS

For instruments shipped 12/92 and after (serial numbers 216 and above)

206709	4-in. for Wafer with Flat/Square Substrate
216186	4-in. for Wafer with Notch
206717	5-in. for Wafer with Flat/Square Substrate
216194	5-in. for Wafer with Notch
206725	6-in. for Wafer with Flat/Square Substrate
206733	8-in. for Wafer with Notch

STANDARD PRECISION LOCATORS

For instruments shipped before 12/92 (serial numbers below 216)

155764	2-in. for Wafer with Flat/Square Substrate
143049	3-in. for Wafer with Flat/Square Substrate
134716	4-in. for Wafer with Flat/Square Substrate
134708	5-in. for Wafer with Flat/Square Substrate
136549	5-in. for Wafer with Notch
134694	6-in. for Wafer with Flat/Square Substrate
134686	8-in. for Wafer with Notch
181714	8-in. for Wafer with Flat/Square Substrate
199915	48-mm Disk, 12-mm ID
145610	65-mm Disk, 20-mm ID
119938	95-mm Disk, 25-mm ID
119946	130-mm Disk, 40-mm ID

OPTIONAL PRECISION LOCATORS

155756	2-in. Wafer Stress for Wafer with Flat/Square Substrate
143030	3-in. Wafer Stress for Wafer with Flat/Square Substrate
134902	4-in. Wafer Stress for Wafer with Flat/Square Substrate
134899	5-in. Wafer Stress for Wafer with Flat/Square Substrate
143960	5-in. Wafer Stress for Wafer with Notch
134872	6-in. Wafer Stress for Wafer with Flat/Square Substrate
134880	8-in. Wafer Stress for Wafer with Notch
183741	8-in. Wafer Stress for Wafer with Flat/Square Substrate

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120383 Kit 203.50

REPLACEMENT STYLI

STANDARD MEASUREMENT HEAD

139793	Stylus, 50-μm radius, 60 degrees
076120	Stylus, 25-μm radius, 60 degrees
014630	Stylus, 12.5-μm radius, 60 degrees
014621	Stylus, 5-μm radius, 60 degrees
014648	Stylus, 1.5- to 2.5-μm radius, 60 degrees
014656	Stylus, 1.5- to 2.5-μm radius, 45 degrees
184101	Stylus, 2 ±0.1-μm radius, 60 degrees
008508	Stylus, submicrometer radius, 70 degrees (includes SEM documents)
086444	Stylus, 0.1- to 0.2-μm radius, 70 degrees. *LIMITED AVAILABILITY.* (Includes SEM documents.)
146226	Stylus, 50-μm knife, 2-μm radius, 60 degrees

MICROHEAD LOW MOMENT MEASUREMENT HEAD

240532	L-stylus, 12.5-μm radius, 60 degrees
217190	L-stylus, 5-μm radius, 60 degrees
217182	L-stylus, 2-μm radius, 60 degrees
238203	L-stylus, 1.9- to 2.1-μm, 60 degrees (includes SEM documents)
217247	L-stylus, 0.3- to 0.8-μm radius, 70 degrees
217212	L-stylus, 0.1- to 0.2-μm radius, 70 degrees

STEP HEIGHT AND SURFACE ROUGHNESS STANDARDS–QUARTZ MOUNT

SET OF THREE THIN-FILM STEP HEIGHT STANDARDS

SHS-0003A Includes:
Step Height, 180Å
Step Height, 440Å
Step Height, 880Å

SET OF FOUR THIN-FILM STEP HEIGHT STANDARDS

SHS-0004A Includes:
Step Height, 440Å
Step Height, 880Å
Step Height, 4500Å
Step Height, 9400Å

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INDIVIDUAL THIN-FILM STEP HEIGHT STANDARDS

SHS-80A	Step Height, 80Å
SHS-180A	Step Height, 180Å
SHS-440A	Step Height, 440Å
SHS-880A	Step Height, 880Å
SHS-4500A	Step Height, 4500Å
SHS-9400A	Step Height, 9400Å

SET OF THREE THICK-FILM STEP HEIGHT STANDARDS

SHS-0003M Includes:
Step Height, 1.8 μm
Step Height, 8.0 μm
Step Height, 24.0 μm

SET OF SIX THICK-FILM STEP HEIGHT STANDARDS

SHS-0006M Includes:
Step Height, 1.8 μm
Step Height, 4.5 μm
Step Height, 8.0 μm
Step Height, 14.5 μm
Step Height, 19.5 μm
Step Height, 24.0 μm

INDIVIDUAL THICK-FILM STEP HEIGHT STANDARDS

SHS-1.8M	Step Height, 1.8 μm
SHS-4.5M	Step Height, 4.5 μm
SHS-8.0M	Step Height, 8.0 μm
SHS-14.5M	Step Height, 14.5 μm
SHS-19.5M	Step Height, 19.5 μm
SHS-24.0M	Step Height, 24.0 μm

SET OF SIX THIN-FILM STEP HEIGHT/ROUGHNESS STANDARDS

P-0006 Includes:
Step Height, 880Å
Step Height, 4500Å
Step Height, 9400Å
Roughness Standard, 220Å
Roughness Standard, 440Å
Roughness Standard, 2250Å

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SET OF FIVE THICK-FILM STEP HEIGHT/ROUGHNESS STANDARDS

P-0005 Includes:
Step Height, 1.8 μm
Step Height, 8 μm
Step Height, 24 μm
Roughness Standard, 2250Å
Roughness Standard, 4700Å

SET OF FIVE ROUGHNESS STANDARDS

RAS-0005A Includes:
Roughness Standard, 90Å
Roughness Standard, 220Å
Roughness Standard, 440Å
Roughness Standard, 2250Å
Roughness Standard, 4700Å

SET OF THREE ROUGHNESS STANDARDS

RAS-0003A Includes:
Roughness Standard, 90Å
Roughness Standard, 440Å
Roughness Standard, 4700Å

INDIVIDUAL ROUGHNESS STANDARDS

RAS-90A	Roughness Standard, 90Å
RAS-220A	Roughness Standard, 220Å
RAS-440A	Roughness Standard, 440Å
RAS-900A	Roughness Standard, 900Å
RAS-2250A	Roughness Standard, 2250Å
RAS-4700A	Roughness Standard, 4700Å

STEP HEIGHT AND SURFACE ROUGHNESS STANDARDS–WAFER MOUNT

INDIVIDUAL THIN FILM STEP HEIGHT STANDARDS

SHS4-80A	Step Height, 80Å, 100 mm
SHS5-80A	Step Height, 80Å, 125 mm
SHS6-80A	Step Height, 80Å, 150 mm
SHS4-180A	Step Height, 180Å, 100 mm
SHS5-180A	Step Height, 180Å, 125 mm
SHS6-180A	Step Height, 180Å, 150 mm
SHS4-440A	Step Height, 440Å, 100 mm

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SHS5-440A	Step Height, 440Å, 125 mm
SHS6-440A	Step Height, 440Å, 150 mm
SHS4-880A	Step Height, 880Å, 100 mm
SHS5-880A	Step Height, 880Å, 125 mm
SHS6-880A	Step Height, 880Å, 150 mm
SHS4-1800A	Step Height, 1800Å, 100 mm
SHS5-1800A	Step Height, 1800Å, 125 mm
SHS6-1800A	Step Height, 1800Å, 150 mm
SHS4-4500A	Step Height, 4500Å, 100 mm
SHS5-4500A	Step Height, 4500Å, 125 mm
SHS6-4500A	Step Height, 4500Å, 150 mm
SHS4-9400A	Step Height, 9400Å, 100 mm
SHS5-9400A	Step Height, 9400Å, 125 mm
SHS6-9400A	Step Height, 9400Å, 150 mm

INDIVIDUAL THICK FILM STEP HEIGHT STANDARDS

SHS4-1.8M	Step Height, 1.8 μm, 100 mm
SHS5-1.8M	Step Height, 1.8 μm, 125 mm
SHS6-1.8M	Step Height, 1.8 μm, 150 mm
SHS4-4.5M	Step Height, 4.5 μm, 100 mm
SHS5-4.5M	Step Height, 4.5 μm, 125 mm
SHS6-4.5M	Step Height, 4.5 μm, 150 mm
SHS4-8.0M	Step Height, 8.0 μm, 100 mm
SHS5-8.0M	Step Height, 8.0 μm, 125 mm
SHS6-8.0M	Step Height, 8.0 μm, 150 mm
SHS4-14.5M	Step Height, 14.5 μm, 100 mm
SHS5-14.5M	Step Height, 14.5 μm, 125 mm
SHS6-14.5M	Step Height, 14.5 μm, 150 mm
SHS4-19.5M	Step Height, 19.5 μm, 100 mm
SHS5-19.5M	Step Height, 19.5 μm, 125 mm
SHS6-19.5M	Step Height, 19.5 μm, 150 mm
SHS4-24.0M	Step Height, 24.0 μm, 100 mm
SHS5-24.0M	Step Height, 24.0 μm, 125 mm
SHS6-24.0M	Step Height, 24.0 μm, 150 mm
SHS4-50.0M	Step Height, 50.0 μm, 100 mm
SHS5-50.0M	Step Height, 50.0 μm, 125 mm
SHS6-50.0M	Step Height, 50.0 μm, 150 mm

Note: A 10% discount is given for ordering three or four standards. A 15% discount is given for ordering five or more standards.

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APPENDIX F: P-2 Version 1.6.5 Release Notes

This appendix contains information about features that have been added, software problems that have been resolved, and software problems that are known to exist at the time of release of Tencor P-2 software version 1.6.5. Included are installation instructions for this software version.

Note: This revision supersedes version 1.6.4 release notes, and installation instructions in Appendix B, "Installing Upgraded Tencor P-2 Software." This appendix also includes notes for the Tencor P-2 Offline Program version 1.6.1.

INSTALLING TENCOR P-2 VERSION 1.6.5 SOFTWARE

The upgrade installation package consists of five Install diskettes:

- System and Utilities (also serves as instrument Boot diskette)
- Memory Manager (preconfigured QEMM files)
- Application

The package might also include one or more of the following depending on which options you have ordered:

- One Options diskette
- One database tutorial diskette

PERFORMING THE BASIC INSTALLATION

The basic installation procedure replaces the existing CONFIG.SYS and AUTOEXEC.BAT files on the instrument. If the instrument has been specially configured for network connection or specific TSR programs, be sure to save the current CONFIG.SYS and AUTOEXEC.BAT files before installing the version 1.6.5 software (see below).

To install version 1.6.5 software:

1. If MS-DOS 6.22 or greater has not been installed on the instrument, install it according to its installation instructions. Be sure to back up your CONFIG.SYS and AUTOEXEC.BAT files before starting, because the MS-DOS setup program modifies them in such a way that they cannot be used on the instrument. After DOS setup, do not reboot immediately but go to the next profiler software installation step.
2. Insert the INSTALL #1 (System and Utilities) diskette and press the Reset button. After a brief time the instrument asks if you wish to install the profiler software. Type *y* and press ENTER.
3. The install program proceeds with the installation, copying files from the diskette to the instrument's hard disk. After a brief time, the instrument prompts you to insert the INSTALL #2 (Memory Manager) diskette. Do so, then press any key to continue the installation process.

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4. The instrument asks you which supported printer you wish to install. Type the number corresponding to the desired printer (if in doubt, type *1* for an Epson/IBM-compatible dot-matrix printer) and press ENTER.
5. The instrument asks if you wish to install the PrintCache print spooler. Type *n* and press ENTER. The PrintCache installation must be performed *after* the Tencor P-2 software installation is complete, *before* resetting the computer. If you want to use PrintCache, see the "PrintCache Installation Procedure" later in this section.
6. The instrument prompts you to insert the INSTALL #3 (Application) diskette. Do so, then press any key to continue the installation process.
7. After copying more files to the hard disk, the instrument asks if you wish to upgrade the installed options. If you have an Options diskette with your installation package, type *y* and press ENTER. Follow the diskette insertion instructions to install your new options. If you do not have an Options diskette, type *n* and press ENTER.
8. The instrument prompts you to insert the INSTALL #4 diskette (video drive A or B). Depending on which video PCB is installed in the unit, follow the instructions on the screen and insert the proper video drive diskette. Then press any key to continue the installation process.
9. When instructed, reinsert the INSTALL #1 diskette.
10. When the instrument informs you that the installation has successfully completed, remove the diskette. If you want to install the PrintCache print spooler software, perform the installation now. Otherwise, press the Reset button.
11. Verify from the information on the screen that all expected options are enabled.
12. Return to DOS and make sure you are in the C:\TENCOR directory. If not, type *cd \tencor* and press ENTER. Slide the write-protect tab on the INSTALL #3 (Application) diskette to the write-enable position (away from the edge of the diskette, so that the small rectangular opening is blocked). Insert the diskette into the floppy drive. Type the command *bakupcal* and press ENTER. Note for beta test site users: If you have been running the instrument software from a directory other than C:\TENCOR, be sure to type the *bakupcal* command from that directory.
13. Remove the INSTALL #3 diskette from the drive. Slide the write-protect tab back into the write-protect position (toward the edge of the diskette, unblocking the small rectangular opening).

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INSTALLING PRINTCACHE SOFTWARE

The instrument startup programs have been preconfigured to sense whether PrintCache has been installed and to start it up configured for the selected printer. For the preconfigured startup programs to work, follow the PrintCache installation procedure exactly as described. The PrintCache installation program has a light-blue screen and is set up as a series of interactive queries. Always press ENTER to commit to a selection in the PrintCache installation program.

To install the PrintCache software:

1. At the DOS prompt, insert the 3.5-in. PrintCache installation diskette into drive A.
2. Type *a:* and press ENTER.
3. At the A: prompt, type *install* and press ENTER.
4. Select the default hard disk C (critical step).
5. Select the default PrintCache directory C:\PCACHE (critical step).
6. Select the GENERIC printer type (critical step).
7. Select LPT1: for the printer connection port (critical step).
8. Skip the printer port configuration test (not necessary, preconfigured).
9. Select LPT1: for the input port to the PrintCache buffer (critical step).
10. Select Disk Drive C: for the buffer type (critical step).
11. Select 1 MB for the default buffer size.
12. Do not enable the pop-up menu.
13. Skip the update of AUTOEXEC.BAT (critical step). Startup of PrintCache has been preconfigured.
14. Skip Windows installation unless the instrument is also being used as a Windows workstation.
15. Skip the printout of the settings.
16. Skip display of the README file unless you need information on printers not supported by Tencor Instruments.
17. Skip the printer port test unless there is a suspected problem in the printer port.
18. After the PrintCache installation is complete, follow steps 10–12 in "Performing the Basic Installation" earlier in this section.

NOTE:	**For users upgrading to Tencor P-2 software version 1.6.5 from versions prior to 1.4.2, it is necessary that you convert any recipes, sequences, and data that was created with the older version if you wish to use it with version 1.6.5. It is essential that you perform this conversion before taking any new data with the instrument. Instructions appear in the following section.**

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CONVERTING PREVIOUS VERSION FILES TO VERSION 1.6.5 FORMAT

Recipes, sequences, and data generated with versions of software prior to 1.4.2 must be converted to version 1.6.5 format if you wish to make use of them. The conversion program does not destroy the original files and works for files stored on either the hard disk or on diskettes. You must convert files on the hard disk first.

To convert previous version files to 1.6.5 format:

1. Choose To DOS from the Exit menu. Type *y* to confirm that you wish to return to DOS when prompted, then press ENTER.
2. If the DOS prompt that appears is C:\TENCOR, go to step 3. If the DOS prompt that appears is other than C:\TENCOR, type *c:* and press ENTER, then type *cd \tencor* and press ENTER again.
3. Type *convdb* and press ENTER.
4. When the conversion process is complete and the C:\TENCOR prompt returns, type *p2* (or *p2h* if your instrument has a wafer handler) and press ENTER to run the main program.
5. Press ENTER again when prompted to initialize the software.
6. Verify that the recipes, sequences, and data have been converted.

INSTALLING SOFTWARE OPTIONS

If you want to add new options after the installation of the basic software is complete (if, for example, you have purchased an additional software option or options), perform the following procedure:

To install software options:

1. Verify that the serial number printed on the diskette label corresponds to the serial number of your instrument and that the options that you have purchased are checked as enabled.
2. Insert the diskette into the floppy drive and press RESET. The instrument computer reboots automatically and adds the additional options to the instrument.
3. When the first instrument software screen appears (the blue rectangle with the instrument information, which remains until you press ENTER), verify that the new option or options have been added to the list.

Added options are saved on the instrument computer's hard disk even if you later upgrade to a new version of the basic software. You should still save the add option diskette in the remote case of a hardware problem.

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SOFTWARE FEATURES ADDED IN VERSION 1.6.5

Support for Video Blaster SE100

- The new software release supports the Video Blaster SE-100 board. It also supports the VGA graphics display mode when the program is in the Overlay mode. This prevents the appearance of black lines to the left of the vertical lines on the screen and allows improved performance of VGA boards.

SOFTWARE PROBLEMS CORRECTED IN VERSION 1.6.4

Excessive Pitting with Extended Range MicroHead

- Version 1.6.2 made an unnecessary stylus force adjustment during MicroHead stylus force calibration, causing excessive surface pitting with the Extended Range MicroHead. This error has been corrected in version 1.6.4.

Handler Puck Striking Handler Door

- Previous versions failed to make sure that the handler door was open before signaling the handler to load or unload a wafer during manual loads. This occasionally results in the handler puck striking the door if the door did not open immediately. This omission has been corrected in version 1.6.4.

Inability to Disable Handler

- Previous versions were incapable of disabling the handler if the handler had only one cassette locator. This problem has been corrected in version 1.6.4.

Misleading Handler Initialization Error Messages

- Handler initialization has been improved, resulting in more accurate error messages if either the handler or the communication channel to it is malfunctioning.

Support for Video Blaster

- The Video Blaster FS200 has been added to support the units shipped after February 1995.

SOFTWARE PROBLEMS PRESENT IN VERSION 1.6.4

Theta Rotation to Zero Degrees in Die Grid with Theta Deskew Enabled

- When deskew with theta is enabled, the stage is at an angle other than zero degrees, and die grid motion is programmed into the sequence stage screen, the stage rotates to an angle of zero degrees. There is no workaround other than to avoid the use of die grid motion under such circumstances.

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Printer Operations

- When the PrintCache print spooler is installed, the instrument software is unable to detect any printer problem or condition that can prevent printing. Information to be printed continues to be sent to the print spooler until the spooler's buffer becomes full; then the instrument locks up until the printer problem is corrected and the waiting information can be sent to the print spooler's buffer. No information is lost because of this, unless it is impossible to correct the printer problem.

Using the HP PaintJet Printer

- If you wish to use an HP PaintJet printer with version 1.6.2, the PrintCache print buffer software must be installed, or the system becomes corrupted. See the note above on PrintCache installation and the "PrintCache Installation Procedure" in Appendix B, "Installing Upgraded Tencor P-2 Software."

Double-Clicking of Keystrokes

- *For instruments with the old-style built-in keyboard only:*
  It is possible that the built-in keyboard responds to keystrokes as if the key had been pressed twice or more. Pressing the Reset button almost always clears this problem. If the double-clicking persists, press Reset again. The problem can also be cleared by choosing Keyboard from the Diag menu and selecting [F1: Reset]. You might have to press this key more than once.

Stage Motion Trackball Usage

- When using the trackball to control X-Y stage motion, especially at high speed, there is a period of up to 10 sec. during which normal keystrokes (except STOP and ESC) are disabled to allow time for the stage to complete its motion. During this time, normal keystrokes might be remembered and executed after motion is complete. Avoid repeated keystrokes during this critical time, even if the stage appears to have stopped.

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Pressing STOP During "Sample Too High" Elevator Rise

- There has been a report of instrument lockup after pressing STOP when the elevator was rising as a result of a "Sample Too High" condition during a sensor drop. Avoid pressing any keys while the elevator is rising as a result of a "Sample Too High" condition, and allow the rise to continue until it is done. The elevator rise can take up to four individual motions, depending on the height of the sample.

Vacuum Status Display

- In handler-equipped instruments, if the handler is disabled, the vacuum status display at the bottom of the screen is inactive at startup, even if stage vacuum is on. To make sure the vacuum status is displayed correctly, press VAC once. This toggles the vacuum, so it might be necessary to press it a second time to produce the desired vacuum state.

Sequence Sort Setup

- It is possible to set up sequence sorting with invalid recipe parameters. This can occur if either the surface analysis parameter selections in a recipe used in sorting or a Recipe ID in a sequence location are changed after the sequence sort parameters are set up. To avoid this problem, always set up recipes and sequence location lists in their final configurations before setting up the sort parameters.

Stress Analysis

- Pressing the [F3: Recalc] key causes an incorrect low-pass filtering of already filtered data, for data recalled from the database, resulting in slight changes to the computed stress parameters.

Removing Diskette While Writing

- Removing a diskette while the program is in the process of writing to it, for example during a database backup, might result in corruption of the Extended CMOS Configuration Memory. On subsequent resets, the startup self-test program detects the error and stalls until the F1 key is pressed, but before the display has been activated. This has occurred once in testing and has not been duplicated, and could be related to SECS being enabled at the same time. Avoid removing the diskette while it is being written to; in emergency situations, press the Reset button instead.

Stopping the Handler

- Occasionally, pressing STOP to halt handler operation interferes with a critical state of the handler. The *Tencor P-2 User Manual* identifies the critical states in terms of handler motions, and contains recovery procedures.

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Wafer Sensed on Instrument Stage, Puck, or Aligner when No Wafer is Present

- The instrument occasionally indicates that there is a wafer in a position where there is none, for example, on the instrument stage or on the puck. This error has been verified in some situations where semi-automatic transfers from one slot to another are followed by the initiation of a cassette sequence. There are also a number of other possible causes, none of which have been verified.

  Under most such situations, the instrument *twice* requests confirmation that the wafer is no longer present. This is normal operation to help guard against accidental operator keystrokes. On some occasions, this normal recovery procedure is not entered, and the situation is more difficult to recover from.

  It might be possible to recover from the situation by reversing the sequence of wafer moves that occurred prior to the error, or by moving the wafer in the indicated slot to the position of the mistakenly sensed wafer and back again. It might also be possible to recover by reinitializing the handler or by pressing the Reset button on the rear surface of the handler cover (*not* the Reset button on the instrument).

  It is possible to avoid such events, if they are associated with the use of semi-automatic mode, by avoiding the use of this mode to transfer wafers from one slot to another.

Scan Processing Performance Improvement in Version 1.5.x and 1.6.x

- *For instruments with 80386-based computers:*
  Versions 1.5.*x* and 1.6.*x* contain a number of enhancements and corrections that increase the flexibility and applicability of Tencor Instruments profilers. As a result of these features, customers taking long scans might experience much longer post-scan processing times than in previous versions. Additional processing time is approximately 4 sec. for each 10 sec. of scan. Such processing times can be drastically reduced by installing a floating-point coprocessor (Intel 80387 or equivalent). Floating-point processors are available from Tencor Instruments and can be installed by a Tencor Instruments service engineer. Alternatively, compatible floating-point coprocessors are available from most PC computer products retailers for customer installation. The clock frequency of the coprocessor must match, or be higher than, the clock frequency of the 80386 chip in the instrument computer to be compatible with the instrument. Call Tencor Instruments Service for information.

MicroHead Stylus Force Calibration Setting Lockup

- If after lowering the stylus on a unit with Microhead, you select the Stylus Force option from the Calibration menu, and then set to Parameter Settings and pick F1:Test *twice*, you receive an error message and the unit aborts to the DOS prompt. You do not need to select F1:Test from this second parameter menu.

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SOFTWARE FEATURES CHANGED OR ADDED IN VERSION 1.6.3

User-nameable ASCII Spreadsheet-format files

- The ability to select the name of spreadsheet export files was added to version 1.6.3. As a consequence of this, the ability to export spreadsheet files during a sequence was removed to avoid interrupting the sequence to name the spreadsheet file for each location.

3-D Scan Procedure

- The 3-D scan procedure was changed slightly to help reduce the vertical offset typical for the first 3-D trace. This is noticeable as a double force lift, plus a double "checking for contact" message with a MicroHead. The change does not provide a complete solution for the problem, and might not have any apparent effect at all on some instruments.

HARDWARE FEATURES CHANGED OR ADDED IN VERSION 1.6.3

Blank Screen on Reset

- In instruments with the Video Blaster video overlay card, the screen might be temporarily blank after pressing the Reset button until the profiler software startup screen is displayed. If you desire to see the normal boot-up messages appear on the screen, perform a reset by pressing CTRL+ALT+DEL, or by turning the power off, waiting 5 sec., and turning the power back on.

  In older Tencor P-2 systems without the Video Blaster overlay card (P-2s manufactured before mid-1993), the screen is blank until the profiler software startup is executed from AUTOEXEC.BAT.

  Please contact your Tencor Instruments service office if you have any questions about your system configuration.

SOFTWARE PROBLEMS CORRECTED IN VERSION 1.6.3

Stage Maximum Limit Save

- In versions 1.6 through 1.6.2, the stage maximum X and Y limits were always set to the stage dimension maximum for the instrument at startup. This has been corrected to allow retention of maximum limits that are less than the stage dimension maximum.

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Stress Analysis after Measurement Head Change

- In versions 1.6 through 1.6.2, switching measurement head types between the pre- and post-stress scans resulted in incorrect stress measurements. This has been corrected in version 1.6.3.

SOFTWARE FEATURES CHANGED OR ADDED IN VERSION 1.6.2

Support for New Operator Keypad

- Software version 1.6.2 supports the new built-in operator keypad that replaces both the old model keypad and the optional external keyboard on Tencor P-2 instruments shipped after February 28, 1994.

  The new keyboard is fully compatible with the standard PC/AT 101-key enhanced keyboard formerly offered as an option. It includes a Microsoft compatible integrated trackball pointing device. Figure F-1 illustrates the new keyboard and shows the location of the keys.

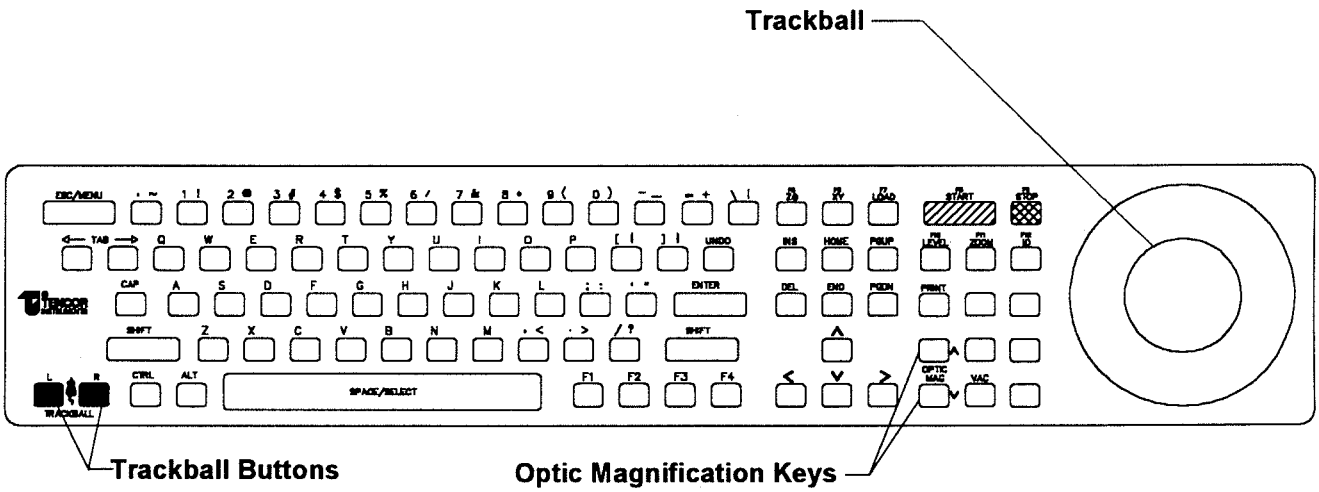


Figure F-1 The 101-key Enhanced AT Keyboard with Trackball

The actions of the keys are exactly as described in Section 3.2.3, "Remote Keyboard," except that two dedicated Optic Magnification keys have been added to control the magnification (zoom). Optic Magnification can also be controlled as in previous versions.

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New Profiler Printer Support Package

- A new software package is now available to provide extended support for other printers not otherwise supported by the Tencor P-2. The Tencor Profiler Printer Support Package (Tencor Part No. 271225) uses Pizazz® Plus, a software package from Applications Techniques, Inc., and contains a setup diskette containing files to map screen colors to printer colors or gray scales and to start up the Pizazz Plus printer driver when the instrument is turned on or reset. Color map support for the Hewlett-Packard Deskjet 550C and gray scale map support for the Hewlett-Packard LaserJet series are included.

Manual Sequence Safety Lift

- The safety lift raising the elevator has been removed from the Manual sequence. The feature caused major inconvenience to operators using the Manual sequence, and it is not possible to effectively provide a safety lift only at the start of a sequence, as in Automatic sequence mode. Users requiring some safety when operating in Manual sequence mode should use the manual LOAD key, which causes an elevator rise to the safety position SECS Data Transfer Disabling.
- In previous versions, it was possible to inadvertently disable automatic SECS data transfer to a host computer in a sequence. This would occur when the sequence also saved or printed data, and a single recipe was previously run in which the SECS data transfer was disabled via the pop-up window after scanning or during saves. This feature proved to be inconvenient for some users and is believed to be non-critical for all others, so it has been eliminated in version 1.6.2. To disable automatic SECS data transfer in a sequence, use the SECS configuration pop-up window.

SOFTWARE PROBLEMS CORRECTED IN VERSION 1.6.2

Theta Position with Non-theta Deskew

- In previous versions, the stage would be rotated to an angle of zero degrees at the start of a Manual sequence program with standard deskew, that is, one without theta rotation. This is no longer a problem and it is now possible to run a standard deskew Manual sequence with a fixed theta angle. When creating such a sequence, the theta position desired must be set initially and be constant throughout the sequence setup.

"Sawtooth" Data Trace Display with Failed Automatic Cursor Positioning

- When using Automatic Cursor Positioning and negative relative-cursor positions, the data trace display could become a "sawtooth," occasionally shifted up or down off the data display grid. This has been found to occur only when no feature has been detected. One cause for this problem was found and eliminated in version 1.6.2, after which the problem could not be duplicated.

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SOFTWARE PROBLEMS CORRECTED IN VERSION 1.6.1

Inability to Import Recipes

- Version 1.6 (only) contains an error that makes recipe import impossible. This error has been corrected in version 1.6.1.

Accidental Recalculation of Linearity Table

- In version 1.6, it was possible to recalculate the linearity table using typed-in coefficients with a measurement head containing an EEPROM calibration file, by pressing the [F1: Calibrate] key in the Head Setup window. This results in a less accurate linearity table and a reduced calibration reliability. In version 1.6.1, it is no longer possible to recalculate the linearity table using typed-in coefficients if a measurement head with an EEPROM calibration file is installed. Measurement heads without an EEPROM calibration continue to use the coefficient method to calculate the linearity table.

SOFTWARE PROBLEMS CORRECTED IN VERSION 1.6

Permanent MicroHead Calibration Settings

- The MicroHead calibration parameters Initial Drop Force and Minimum Contact Force are now being stored on disk, as a result of field reports that sensor drop failures were being observed after MicroHeads were in service for some time.

Manual Sequence Data Save Errors

- Scan summary data was incorrectly saved in manual sequences using more than one recipe with different sets of surface analysis parameters. It was most likely to be a problem when using multiple analysis with different parameters. In version 1.6, this problem is no longer present.

Extended Roughness Parameter Vertical Range

- For extended roughness parameters that use vertical distance modifiers (t_p, HSC, Pc, S_m), some of the displayed English unit selections are incorrect by a factor of 10. The unit settings for 0.01 mil, 0.1 mil, and 1 mil should be 1 µin., 0.01 mil, and 0.1 mil, respectively. Internally, they are used correctly in computations. This error is also present in versions 1.5 and 1.5.1. The English unit settings 0.001 µin., 0.01 µin., and 0.1 µin. are displayed correctly, as are all metric selections. This problem is corrected in version 1.6.

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Stylus Drop "Sample Too High" Anomalies

- In some pre-release versions of version 1.6, an error in memory management can result in temporary screen image corruption and possible lockup of the instrument when attempts to lower the sensor fail and the elevator is at the top of its travel. Lockup has been observed with repeated attempts to lower the sensor. Failure to lower the sensor in this manner indicates a calibration or configuration problem, either in hardware adjustment or in the measurement head setup performed in the instrument software. This problem is corrected in version 1.6.

Difficulty in Setting Relative Cursors

- In versions 1.5, 1.5.1, and pre-release versions of 1.6, it was not possible to set negative cursor values of less than -999 in the Recipe screen. If the cursors were set in the Data screen, the [F3: Cursors] key was able to set values of less than -999 in the cursor fields. Also, the values in the cursor fields were not set to relative values when toggling the Edge parameter on. This problem is corrected in version 1.6.

SOFTWARE PROBLEMS CORRECTED IN VERSION 1.5.1

These software problems have been resolved in version 1.5.1.

3-D Theta Rotation

- In version 1.5, the Theta Axis would rotate to zero degrees for the second trace of 3-D scans that started with a Theta position other than zero. This has been corrected in version 1.5.1.

SECS Equipment ID

- In versions 1.3.x through 1.5, the SECS Configuration window allowed only four digits to be entered for Equipment ID. Version 1.5.1 has been corrected to allow five digits, with numeric values from 0 through 32,767.

Edge Detection Cursor Positioning

- In version 1.5, leveling cursor positions to the left of the detected edge would automatically collapse to the beginning of the scan if there was insufficient distance between the beginning of the scan and the detected edge. In version 1.5.1, both leveling and measurement cursor positions to the left of the edge are adjusted to keep the same relative distance between the cursors and the detected edge. Note that it is possible for cursors to start riding up an ascending edge if they are set too close to the edge and the distance between the edge and the start of the scan becomes too small.

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Stress Pre-scan without Database Option

- In versions 1.4.*x* through 1.5, in instruments with the Wafer Stress Option but without the Database Option installed, the instrument would fail to recall Stress pre-scans, thereby making Stress difference measurements impossible. This has been corrected in version 1.5.1.

Error in Z Position Display After Move to Load

- In version 1.5, with the elevator Load Limit set, after moving to a Load/Unload position and entering the Motion screen, the Z position would be displayed incorrectly. This problem has been corrected in version 1.5.1.

Error in X-Y Position Display After Safety Stop

- In version 1.5, after a motion stop caused by opening a door or side panel with the safety interlock enabled, the X-Y stage position would not be correctly updated. This caused incorrect display of the X-Y position in the Motion screen and occasional motion limit errors. This problem has been corrected in version 1.5.1.

Incorrect Error Message During Export

- During Export operations, attempting to write to a write-protected or damaged disk resulted in a cryptic, uninformative error message. This problem has been corrected in version 1.5.1.

Print Spooler Installation

- In version 1.5, when installation was started by booting from the first Installation diskette, the PrintCache print spooler was not installed although the installation program said it was. This problem has been corrected in version 1.5.1.

CONFIG.SYS Installation

- In version 1.5, when installation was started by running the INSTALL program from DOS and the instrument was equipped with 4 MB of memory, the incorrect CONFIG.SYS was installed on the instrument. This problem has been corrected in version 1.5.1.

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DOCUMENTATION ERRORS

Incorrect Documentation of Theta Deskew

- Starting with version 1.4, the instructions in Section 10.3.2 of the *Tencor P-2 User's Manual* for performing theta deskew in a sequence are incorrect. The second deskew point is not revisited for a third alignment. That procedure became obsolete with the introduction of programmable theta coordinates with theta deskew. The newer method requires a very precise alignment of the stage Center Offset coordinates, which must currently be performed manually. See Section 6.11, "Setting the Center Offset," for procedures.

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GLOSSARY

2-D Data
Two-dimensional data.

3-D Data
Three-dimensional data.

ASCII Data
ASCII (American Standard Code for Information Exchange) codes are used to represent characters for storage in a computer's memory.

Area
See Total Area

Area +
See Area of Peaks

Area-
See Area of Valleys

Area of Peaks (Area +)
Total area bounded by the leveled baseline and the profile above the baseline.

Area of Valleys (Area-)
Total area bounded by the leveled baseline and the profile below the baseline.

Average Height (Avg)
The average height of all data points between the measurement cursors relative to the leveled baseline.

Average Stress
Average stress is the least square fit of the entire profile.

Avg
See Average Height

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Base

Used (with prefix Up- or Down-) to identify the bottom of the sloping side of a step, to distinguish it from the top of the slope, called the *edge*. See UpBase, DownBase.

Bearing Ratio (t_p)

A reference line is drawn parallel to the mean line and at a preselected or predetermined distance (cutting depth) below the highest peak of the roughness trace within the sampling length. This reference line intersects the roughness trace in one or more subtended lengths. The bearing length is the sum of these subtended lengths. The bearing ratio is the ratio of the bearing length to the sampling length. Also called Bearing Length Ratio.

Center Line

The center line divides the profiles such that all areas above it are equal to all areas below it.

Center Stress

Center stress is the stress computed at the center third of the profile.

Concave

Describes an arc that curves inward from a level reference plane; a valley-like arc.

Contact Speed

Contact speed defines the stylus drop speed at contact with the substrate.

Convex

Describes an arc that curves outward from a level reference plane; a hill-like arc.

CutDp

See Cutting Depth

Cutoff Length

The cutoff length is the wavelength on the filter transmission curve that corresponds to 75 percent transmission. According to the ANSI B46.1 - 1985 standard, 800 μm is the preferred cutoff for most surfaces.

Cutting Depth (CutDp)

A preselected or predetermined distance below the highest peak of a sample. See Bearing Ratio.

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D_q

See Root-Mean-Square Slope

Data-Dependent ID

An identity whose value is not specified by the user but by the data being saved, recalled, restored, or backed up. The Database Manager Option uses five data-dependent IDs—Recipe ID, Sequence ID, Type, Begin Time, and End Time—in its operations.

Data ID Value

The data ID value is a user-defined value that is attached to a subset of data in the database.

Default ID Value

The pound (#) symbol is used as the default ID value in database operations. This is used to identify data when the user does not care what ID value is used for a particular ID or all IDs. The default value can be used in any ID.

Delta Average Mode

The measurement or leveling cursors are expanded into a region, either independently or in tandem, and the data points within the delta width are averaged.

Deskew

Deskew is a feature of the Tencor P-2 that compensates for any translational or rotational errors between different substrates by allowing you to select manually two fixed reference points to be used for calculating stage coordinate values.

DownBase

The bottom of the sloping side of a trough-like feature, or downward step.

DownEdge

The top of the sloping side of a trough-like feature, or downward step.

Edge

The distance to the first rising or falling edge of a step (or the apex of a peak) from the beginning of the profile. Also used (with prefix Up- or Down-) to identify the top of the sloping side of a step, to distinguish it from the bottom of the slope, called the *base*. See UpEdge, DownEdge.

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Finite Impulse Response (FIR)

The Tencor P-2 uses the Finite Impulse Response technique to calculate roughness and waviness from digitized data points.

Form Error

Form error is a deviation from a perfect realization of a nominally specified shape. For example, for a flat surface the form error would be the deviation from flatness. If the deviation is periodic (that is, has waves), the error is termed waviness. If there are many hundreds or thousands of randomly-shaped undulations without a discernible pattern, the error is called roughness. The difference between form error, roughness, and waviness is not precisely defined; it is more a qualitative distinction. See Waviness and Roughness.

HSC

See High Spot Count

Height

The difference in height between two points on the sample surface defined by the positions of the measurement cursors.

High Spot Count (HSC)

The number of profile peaks per unit length projecting through a reference line parallel to and at a given height above a line drawn through the lowest point of the roughness trace, parallel to the mean line. See Peak Count.

Keylock

The keylock limits operator access to Scan recipes and Sequence programs for operational security.

L_q

See Root-Mean-Square Wavelength

Major Data ID

The first three IDs in any database ID window are the major Data IDs.

Manual/Single Scan Mode

The user programs the parameters for a scan into a recipe using a menu. The scan can be specified to be continuous or segmented into sections of equal length.

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Maximum Height (MaxHt)
The maximum height of a trace relative to the zero line within the sampling length.

Max R_a
See Maximum Average Roughness

Maximum Average Roughness (Max R_a)
The trace within the cursors is divided into 19 overlapping sections. Each section is one-tenth of the sampling length. The average roughness (R_a) of each section is calculated, and the maximum is displayed.

Maximum Stress
Maximum stress is the maximum of 13 overlapping sections of one-third of the length and offset across the total profile.

Mean Peak Height (Rpm)
The mean value of the local peak heights of the roughness trace within the sampling length.

Mean Peak Spacing (S_m)
The mean value of the local peak spacing of the roughness trace within the sampling length, where the peaks are defined by the criteria of the Peak Count parameter. See Peak Count..

Mean Step Height (StpMn)
The mean value of step height of all the steps that occur in the sampling length, where the steps are defined as complete pairs of ascending and descending edges.

Minimum Height (Min Ht)
The minimum height of a trace relative to the zero line within the sampling length.

Minor Data ID
The fourth, fifth, sixth, and seventh Data IDs in any database ID window are the minor Data IDs.

Multiscan Average Mode
A scan is repeated up to ten times and the average is calculated automatically.

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Number of Steps (StpN)

The number of steps that occur in the sampling length. These steps are defined as complete pairs of ascending and descending edges.

PC

See Peak Count

Parameters

Measurement attributes such as length, speed, and direction are the parameters used in the Tencor P-2 software.

Peak

The distance between the mean line and the highest peak of the roughness trace or waviness trace within the sampling length.

Peak Count (PC)

The number of peak/valley pairs in the roughness trace per unit length projecting through a band of width b centered about the mean line. Projecting through means that the profile curve climbs above and then falls below the band. Thus, if the profile rises above the band more than once without falling below the band, multiple peaks are not identified. See High Spot Count.

Peak/Valley

The vertical distance between the highest peak and the lowest valley of the roughness or waviness trace, leveled on the mean line. Also known as R_{max} or W_{max}, Maximum Peak-to-Valley Roughness or Waviness.

Profile Length (ProfL)

The length that would be obtained from drawing out the profile in a straight line, within the sampling length.

ProfL

See Profile Length

R_{3z}

See Six-point Height

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R_a
See Roughness Average

R_h
See Roughness Height

R_p
See Peak

R_q
See Root-Mean-Square Roughness

R_t (P/V)
See Peak/Valley

R_v
See Valley

R_z
See Ten-Point Height

RMS
See Root-Mean-Square

Rpm
See Mean Peak Height

RRWG
RRWG stands for raw scan, roughness, waviness, and grid. The RRWG colors represent the individual color options for the graph and grid lines.

Radius
The distance from the center of curvature of the profile arc (assuming a circular profile within the sampling length) to the profile. The measurement cursors define two points of a circular arc. A least squares fit is performed on the points between the cursors.

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Recipe

A recipe is a list of scan parameters.

Recipe ID

The Recipe ID is the name of the generating recipe.

Root-Mean-Square Roughness (R_q)

The root-mean-square or geometric average deviation of the roughness profile from the mean line measured in the sampling length.

Root-Mean-Square (RMS)

The square *root* of the arithmetic *mean* of the *squares* of a set of numbers.

Root-Mean-Square Slope (D_q)

The root-mean-square or geometric average deviation of the slope of the roughness trace.

Root-Mean-Square Wavelength (L_q)

2π times the ratio of the root-mean-square deviation of the profile (R_q) to the root-mean-square slope of the profile (D_q). L_q is a measure of the spacing of local peaks and local valleys, taking into account their relative amplitudes and individual spatial frequencies.

Root-Mean-Square Waviness (W_q)

The root-mean-square or geometric average deviation of the waviness profile from the mean line measured in the sampling length.

Roughness

A surface is said to be rough when the surface's deviation from flatness has many hundreds or thousands of randomly shaped undulations. See also Form Error and Waviness.

Roughness Average (R_a)

The arithmetic average deviation of the absolute values of the roughness profile from the mean line or center line. Also known as Center Line Average Roughness. Also see Center Line.

Roughness Height (R_h)

The difference in height in the roughness profile between the values at the left and right cursor positions of the profile.

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Sampling Length
The length of trace between the cursors.

SD
See Std Dev Heights

SECS Interface
The Semiconductor Equipment Controller Standard (SECS) Interface provided on the Tencor P-2 defines a computer-to-computer communications interface between the Tencor P-2 and a host computer.

S_m
See Mean Peak Spacing

Segmented Scan
The scan is divided into segments of equal length and no data is taken between the segments. Using this method, roughness can be measured over several short lengths spaced equally along a straight line.

Sequence
A program of sequential scans to be performed on a single substrate.

Sequence Identifier
The Sequence ID is the name of the generating sequence program.

Six-Point Height (R_{3z})
The average height difference between the three highest peaks and the three deepest valleys within the cursors measured from a line parallel to the mean line and not crossing the profile.

Slope
The ratio of the difference in vertical positions to the difference in horizontal positions of the measurement cursors. The slope is reported as an angle in degrees.

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Spatial resolution

Spatial resolution is a measure of a profiler's capability to resolve the smallest vertical or horizontal feature on a surface. Four primary factors determine spatial resolution: stylus radius, short wave filtering, vertical resolution, and horizontal resolution. In practice, stylus radius and short wave filtering are the two factors that limit spatial resolution.

Std Dev Heights (SD)

The standard deviation of the local peak heights of the roughness trace about the mean peak height within the sampling length.

Std Dev StepHeights (StpSD)

The standard deviation of step height of all the steps that occur in the sampling length. Steps are defined as complete pairs of ascending and descending edges.

StpMn

See Mean Step Height

StpN

See Number of Steps

StpSD

See Std Dev Step Heights

StpWd

See Width of Step

Stylus Force

The force of the stylus tip when the stylus is in contact with the substrate.

t_p

See Bearing Ratio

TIR

See Total Indicator Runout

Ten-Point Height (R_z)

The average height difference between the five highest peaks and the five deepest valleys within the cursors measured from a line parallel to the mean line.

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Total Indicator Runout (TIR)
The difference in height between the highest and the lowest points within the surface bracketed by the cursors.

Type
Type identifies the type of data that can be saved, recalled, restored, or deleted in the database. The following six preset values are available: raw trace data, point data, sequence results, 3-D data, and any data. Statistics data is supplied within sequence results.

UpBase
The bottom of the sloping side of a step-like feature, or upward step.

UpEdge
The top of the sloping side of a step-like feature, or upward step.

Valley
The distance between the mean line and the lowest valley of the roughness or waviness trace within the sampling length.

W_a
See Waviness Average

W_h
See Waviness Height

W_p
See Peak

W_q
See Root-Mean-Square Waviness

W_t
See Peak/Valley

W_v
See Valley

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Wafer Stress Option

The Tencor P-2 Wafer Stress Option measures the stress level in a deposited film by measuring the deflection or curvature that the stress induces in the substrate. The curvature of the film is determined by calculating the least square fit of the trace data to a circle. Stress values calculated include Average Stress, Maximum Stress, and Center Stress.

Waviness

Waviness of a surface is a periodic deviation from flatness, where the wavelengths generally range from 30 to more than 100 times the average wavelength of the roughness. See also Form Error and Roughness.

Waviness Average (W_a)

The arithmetic average deviation of the absolute values of the waviness profile from the mean line or center line. Also known as Center Line Average Waviness. Also see Center Line.

Waviness Height (W_h)

The difference in height in the waviness profile between the values at the left and right cursor positions of the profile.

Width of Step (StpWd)

The distance between the first rising edge and the next falling edge of a step height plateau.

Wildcard

The star (*) symbol is used as a wildcard value in database operations. When entered in one or all Data IDs, the wildcard tells the database search function to accept data with any value for that field. The wildcard cannot be used when saving data.

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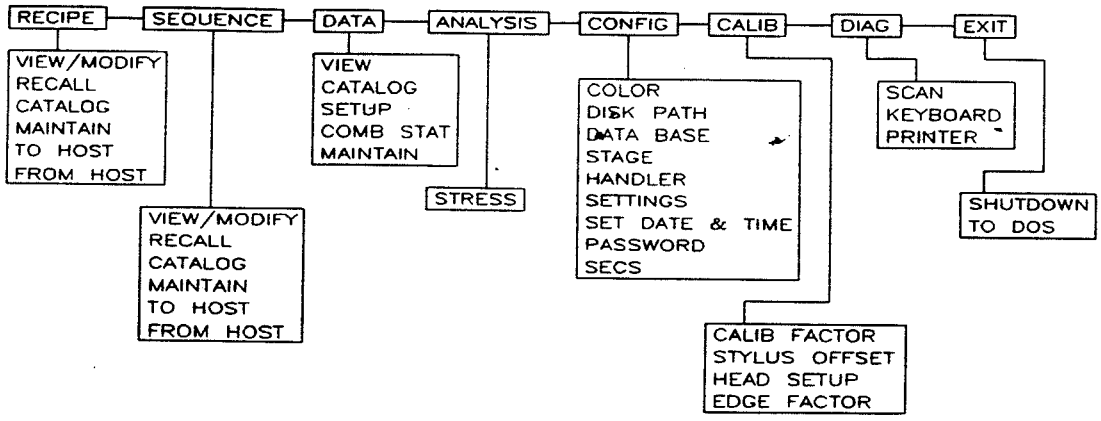
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Alpha-Step® 300 / Tencor® P-2
Operator's Quick Guide



FUNCTION	KEYSTROKE	DESCRIPTION/COMMENTS

LOADING/UNLOADING SAMPLES MANUALLY

To load the sample:		
1. Move stage to the load position.	LOAD	
2. Open measurement area door and place the sample on stage locator.		Verify that the sample has enough clearance under the measurement head.
3. Move stage from load to measurement position.	LOAD	
To unload the sample:		
1. Move stage from measurement to unload position.	LOAD	
2. Open measurement area door and remove the sample.		

LOADING/UNLOADING WAFERS MANUALLY (WAFER HANDLER)

To load the wafer:		
1. Enable handler and configure handler settings:		
• Display the menu bar.	MENU	
• Display the Config menu options.	[→]	Select the Config menu.
• Display the Handler Enable window.	[↓] + ENTER	Select the Handler option in the Config menu.
• Select Enable.	[←] or [→]	
• Display Handler Settings window.	F1	
• Select options.	[←] or [→]	
2. Set aligner to align wafers.		Turn the wafer size selector on the aligner to diameter of wafer.
3. Place the cassette with wafer on the locator.		

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FUNCTION	KEYSTROKE	DESCRIPTION/COMMENTS
4. Set loading options: • Display Handler Load window. • Select Sender in the Source field and type the slot number of the wafer.	LOAD [←] or [→]	
5. Display the Alignment window and set the alignment options.	F1	From the Handler Load window.
6. Load wafer	START	Wafer is loaded.
To unload the wafer: 1. Set unloading options: • Display Handler Unload window. • Select the location of the wafer in the Source field. Type the slot number of the wafer.	LOAD [←] or [→]	
2. Unload wafer.	START	Wafer is unloaded to selected slot.

POSITIONING THE SAMPLE BELOW THE STYLUS (MANUAL)

1. Lower measurement head: • Enable head elevator motion. • Low speed head motion. • High speed head motion.	Zθ [↓] SEL + [↓]	Displays the Motion screen. CAUTION: Do not lower the head onto the sample in high speed mode.
2. Position stage: • Enable XY movement. • Precise XY movement. • High speed XY movement.	XY [↓] [↑] [←] [→], or trackball F1 + F1 SEL + [↓] [↑] [←] [→]	XY coordinates highlighted in green. XY coordinates highlighted in red.

OPTICAL ZOOM (MANUAL)

1. Lower stylus	Zθ + [↓]	Bring the sample into focus.
2. Enable zoom.	ZOOM	From the Motion screen.
3. Adjust video image magnification.	[↓] or [↑]	Use [↓] to decrease magnification and [↑] to increase magnification.
4. Return to motion control.	Zθ or XY	

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FUNCTION	KEYSTROKE	DESCRIPTION/COMMENTS

SELECTING A SEQUENCE PROGRAM

1. Display the menu bar.	MENU	You might have to press MENU several times to display the main menu bar from some screens.
2. Display the Recipe menu options.	[←] or [→]	Select the Recipe menu.
3. Display the Recipe catalog.	[↓] + ENTER	Select the Catalog option in the Recipe menu.
4. Select and recall the desired recipe.	[↓] or [↑] + ENTER	

PROFILING FROM A RECIPE

1. Initiate scan.	START	From the Recipe or the Motion screen.
2. Abort scan.	STOP	

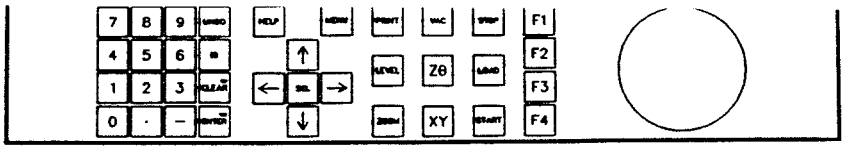
ELECTRONIC DATA LEVELING

1. Enable leveling.	LEVEL	From the Data screen.
2. Enable leveling cursors.	SEL	SEL toggles between the right and left cursors. To activate both cursors, press SEL twice in quick succession.
3. Position cursors.	[←] or [→], or trackball	
4. Expand cursors to define region.	[↓] or [↑]	Delta Average mode.
5. Level data plot.	[F2: Replot] or LEVEL	Replots data according to cursor locations.

MECHANICAL STAGE LEVELING (OPTION)

1. Enable leveling.	LEVEL	From the Data screen.
2. Enable leveling cursors.	SEL	SEL toggles between the right and left cursors. To activate both cursors, press SEL twice in quick succession.
3. Position cursors.	[←] or [→], or trackball	
4. Expand cursors to define region.	[↓] or [↑]	Delta Average mode.
5. Level stage according to cursor locations.	[F3: AutoMechanical]	
6. Confirm stage leveling.	[←] or [→]	Select YES or NO.

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FUNCTION	KEYSTROKE	DESCRIPTION/COMMENTS

SELECTING A SEQUENCE PROGRAM

1. Display the menu bar.	MENU	You might have to press MENU several times to display the main menu bar from some screens.
2. Display the Sequence menu options.	[←] or [→]	Select the Sequence menu.
3. Display the Sequence catalog.	[↓] + ENTER	Select the Catalog option in the Sequence menu.
4. Select and recall the desired Sequence progam.	[↓] or [↑] + ENTER	

RUNNING A SEQUENCE IN AUTOMATIC MODE

1. Initiate sequence.	START	From the Loc, Recipe side of the Sequence program window. (To toggle to the Loc, Recipe side, press F4.) Make sure the start location of the sequence is highlighted.
2. If save option is enabled: Enter the filename to save data.	F2	From the Database Sequence IDs window.
3. If the SECS option is enabled to not upload the file automatically: Enter the filename to upload data.	F2	From the Save SECS IDs window.
4. If deskew option is enabled:		
• Null the stylus.	Z0 + [↓]	The Z value should not change at null position.
• Align the feature.	XY + [↓] [↑] [←] [→] or trackball + ENTER	
• Repeat for the second deskew site.		The sequence is started automatically after the second deskew site is selected.
5. Review data:		
• Display the Sequence data screen.	F1	
• Select the desired loation.	[↓] or [↑]	
• View the selected trace or data.	F2	

PRINTING DATA, RECIPES, OR SEQUENCE PROGRAMS

1. Display screen.		Recipe, Sequence Program, or Data screen.
2. Initiate printing.	PRINT	

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Tencor Profiler Printer Support Package

Tencor

302600-11 Rev. A 1/95

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TENCOR PROFILER PRINTER SUPPORT PACKAGE

The Tencor Profiler Printer Support Package uses Pizazz® Plus, a software package from Applications Techniques, Inc., to provide extended support for printers not otherwise supported by versions 1.6.1 and higher of the Profiler software.

In addition to the copy of Pizazz Plus (version 4.01 or higher), the support package includes a setup diskette containing files to map Profiler screen colors to printer colors or gray scales and to start up Pizazz Plus when the instrument is turned on or reset. Included in these files are

- Color map support for the Hewlett-Packard Deskjet 550/560C
- Gray scale map support for the Hewlett-Packard LaserJet series

INSTALLATION PROCEDURE

To install the Tencor Profiler Printer Support Package:

NOTE:	**The Profiler software must be installed before beginning.**

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Insert the Pizazz Plus installation diskette into the floppy diskette drive.
3. At the DOS prompt, type *a:* and press ENTER.
4. Type *install* and press ENTER to start the installation program.
5. Answer the questions that the installation program asks as follows:
   - The installation directory is C:\PZP, which is the default.
   - The display is a color display.
   - The display adapter type is IBM EGA (VGA adapters are used only in EGA mode).
   - Choose the printer from the list provided. To use the DeskJet 550C with the color map files provided, choose the recommended "True Black" driver.
   - The printer port used is LPT1.
   - Pizazz Plus will load in Overlay mode.
   - The working files directory is C:\PZP, the same as the installation directory.

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You will need to know the type of printer you will be using, because Pizazz Plus creates a different executable file for each printer. Note that after installation is completed, the Pizazz Plus configuration can be changed at any time without the need to repeat this entire installation procedure. See "To switch printer types" later in this document.

NOTE:	**If you choose any printer other than the HP Deskjet 550C in Step 5, you must copy the appropriate color map file to the default color map filename. See the instructions under "Customizing Pizazz Plus."**

6. After the Pizazz Plus installation is complete, remove the diskette from the floppy drive and insert the Tencor Printer Support Package Installation diskette.
7. At the A:\ prompt, type *install* and press ENTER. The color map is automatically set up to give good visibility to 3-D scans using a DeskJet 550C, and other files are copied to the instrument computer's hard disk to correctly load the Pizazz Plus Overlay mode driver.
8. After the Tencor support files installation is complete, press RESET to restart the computer and install the Pizazz Plus driver.

Pizazz Plus is now loaded whenever DOS restarts, before the Profiler program begins. It is invoked whenever a graphical screen print is performed.

CUSTOMIZING PIZAZZ PLUS

Two preset customization files are included on the Tencor installation diskette:

- DJ550C.PZD
- REVGRAY.PZD

At installation, the DJ550C.PZD file is copied to the default Pizazz Plus configuration file named PZP.PZD. This sets up the color map to print the (fixed) 3-D Data screen so that all of the height shadings are visible. It also gives good results for all other screens when the default color scheme is selected.

The second file contains a reverse-gray-scale color map that was tested on a LaserJet II printer.

Either of these files will probably work well with another printer of similar functionality; the gray scale color map, for instance, will probably work with any laser or black-and-white inkjet printer.

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To set up Pizazz Plus to print in gray scales:

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Type PRINTSEL and press ENTER.
3. When prompted, type the appropriate number corresponding to PIZAZZ PLUS FOR BLACK AND WHITE PRINTER and press ENTER.
4. Press RESET.

To set up Pizazz Plus to print in color:

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Type PRINTSEL and press ENTER.
3. When prompted, type the appropriate number corresponding to PIZAZZ PLUS FOR COLOR PRINTER and press ENTER.
4. Press RESET.

To change printers or printer characteristics, it is necessary to modify the default configuration.

To switch printer types:

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Type *cd c:\pzp* and press ENTER.
3. At the C:\PZP> prompt, type *install* and press ENTER.
4. Follow the rest of the procedures starting from Step 5 of "To install the Tencor Profiler Printer Support Package" earlier in this document.

You can further customize Pizazz Plus to change color maps, print orientations, and so forth, via the Pizazz Plus command menu. This menu is disabled in the default configuration used with Profilers, but you can enable it. When enabled, the menu is activated whenever Pizazz Plus is invoked (for example, whenever the Profiler program requests a graphical screen print operation).

To enable the Pizazz Plus Command menu:

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Type *cd c:\pzp* and press ENTER.
3. At the C:\PZP> prompt, type *pzp/m* and press ENTER.
4. Type *cd\tencor* and press ENTER to return to the Profiler run directory.
5. At the C:\TENCOR> prompt, type the Profiler's executable file name (*p2* for a Tencor P-2, *p2h* for a Tencor P-2h, *p10* for a Tencor P-10, and *as5* for an Alpha-Step 500), and press ENTER.

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When defining color maps, it is best to invoke Pizazz Plus when all colors to be mapped are currently displayed; the Pizazz Plus menu does not allow mapping of colors not displayed on the underlying screen. Choosing some alternate menu colors, then viewing some 3-D data in the Data screen, is a fairly easy way to get all available colors displayed.

When the desired results are achieved, it is a good idea to save the settings in a file so that they can be easily set up using the DOS COPY or PRINT SEL command. The current color maps, orientations, cropping, and so forth are saved in a file with a user-specified name and the extension PZD.

To start Pizazz Plus with an Alternate Configuration:

1. Choose To DOS from the Exit menu to exit from the Profiler software.
2. Type PRINTSEL and press ENTER.
3. When prompted, type the number for Pizzaz Plus with User Defined Maps, and press ENTER.
4. Type the name of the .PZD file (leaving off the .PZD extension) and press ENTER.
5. Press RESET.

To disable the Pizazz Plus Command menu:

- Perform the same sequence of steps used to enable the menu. The /m command switch acts like a toggle switch.

TROUBLESHOOTING

Pizazz Plus is a complex program that requires a large amount of memory to execute. In Overlay mode the program gets most of its memory by borrowing from any programs in memory at the time it was invoked. For *some* programs that are active in the background (such as the Tencor Profiler programs), this might create problems. Pizazz Plus has been verified to work only with specific versions of Profiler software, and with Tencor-supported printers. Problems might occur with other Profiler software versions, unsupported printers, additional resident programs, and so forth. The common symptoms of such problems are system lockups, system crashes, graphics corruption, privilege exceptions, and similar malfunctions.

When such problems occur, try editing the Pizazz Plus start-up command line to eliminate the problem. To do so, edit the file PRINTER.BAT, located in the C:\UTIL\ directory. In that file, there are one or more lines to invoke Pizazz Plus, each beginning with PZP and followed by a list of codes called *switches*. Usually the switch /MAWO appears. This line should be changed to read

PZP /MAWO=*nnnn*

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where the *nnnn* represents a four-digit hexadecimal number. For some versions of the Profiler software, that number is 3800, which should be tried first. If that number fails, try working down from 3800 by intervals of 100 hexadecimal, that is, 3700, 3600, ..., 2F00, ..., 2000, then up from 3800 by the same interval, until a number is found that is consistently functional. Numbers below 2000 and above 5000 consistently cause failures, so it is not generally useful to pursue a solution outside this range.

If a problem occurs with a supported printer and the standard instrument configuration, Tencor Instruments is committed to providing a solution. Technical support and advice is available in other cases, but Tencor Instruments makes no commitment to provide a solution.

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