

Operations Manual
for the
Filmetrics F20
Thin-Film Measurement System

Revision 2.0
Copyright © 1998 by Filmetrics, Inc.
All Rights Reserved

Notes by A.M. Wilson Calibration of Tool 1/5/68
With Certified Standards

1. Repeatability of Test Water $\bar{x} = 7499 \pm 0.9$, $n = 10$

$$x_{\min} = 7498 \quad x_{\max} = 7499$$

2. Reproducibility of Test water: ~~is~~ removed after each measurement.

$$n = 10 \quad \bar{x} = 7504 \pm 5.8 \text{ \AA} \quad x_{\min} = 7491$$

$$x_{\max} = 7515$$

3. Std Test Water Reported to be: ~~7494~~ 7494

Thus Tool Has a $+10 \text{ \AA}$ bias!

4. Re Cal. the Base line & ~~zero~~ Dash Current

$$n = 13 \quad \bar{x} = 7494 \pm 6.5 \text{ \AA}$$

$$x_{\min} = 7484$$

$$x_{\max} = 7504$$

$$x_{\text{mode}} = 7496$$

Thus Tool requires Frequent Baseline Cal.
to maintain accuracy

5. Repeat of 4.

$$n = 10 \quad \bar{x} = 7495 \pm 7.3 \text{ \AA}$$

$$x_{\text{mode}} = 7493$$

$$x_{\min} = 7484$$

$$x_{\max} = 7504$$

CE Mandated Warnings



Please read the following instructions carefully to prevent potential shock or fire hazards. This manual should be retained for future use.



Bitte lesen Sie die nachstehende Anleitung sorgfältig durch um Stromschlag und Feuergefahr zu vermeiden. Diese Betriebsanleitung sollte für späteren Gebrauch sorgfältig aufbewahrt werden.



Preghiamo di leggere accuratamente, le sequenti Istruzioni, per evitare Prossimi Incendi e Correnti.



1.

Shock Hazard – Do Not Enter
Achtung Hochspannung – Nicht Berühren
Attenzione Corrent-Forte – Prego non toccare



2.

The front panel's switch is not the power disconnect device. The power cord should be removed after use.

Der Kippschalter an der Vorderseite unterbricht nicht die Stromzuführung. Das Stromkabel sollte nach Gebrauch aus dem Gerät herausgezogen werden.

L'interuttore nella parete frontale non blocca le Corrente. La Corrente viene.



3.

Never expose the unit to water or liquids. Avoid direct sun.

Bringe das Gerät nicht mit Wasser oder einer anderen Flüssigkeiten in Berührung. Vermeide direkte Sonneneinstrahlung.

Evitare contatto con acqua oppure liquidi Infiammabili al Macchineggio. Anche entrate di Sole.

4.



Do not insert any objects into the unit.

Keinen Gegenstand in das Gerät einbringen. Do non inseriamo any obietta into gli unità.

Non mettere ogetti dentro la Macchina.

5.



Do not use near open flame or heat.

Das Gerät nicht in der Nähe einer offenen Flamme oder Hitze benutzen.

Non mettere la Macchina vicino a fuochi oppure Riscaldamenti.

6.



The unit should never be enclosed or blocked.

Das Gerät darf nicht eingeschlossen oder blockiert werden.

La Macchina non chinderla per nessun motivo.

7.



Connect unit only to a properly measured supply. Use only three wire cord which is provided with the unit.

Schließen Sie das Gerät nur an eine ordnungsgemäss vermessene Stromversorgung an. Verwende nur ein dreiadriges Kabel, wie es auch mit dem Gerät ausgeliefert wird.

Montare solo con misura normata. Adoperando solo 3 cavi elettrici cosi come e fornita la Macchina.

Filmetrics, Inc. Software License Agreement

BY COMMENCING USE OF THIS PRODUCT YOU AGREE TO BECOME BOUND BY THE TERMS AND CONDITIONS OF THIS AGREEMENT.

LICENSE

This license agreement ("license") permits you to use one copy of FILMeasure ("Software") on any single computer. The Software is owned by Filmetrics, Inc. ("licensor") and is protected by United States copyright law and international treaty provisions. Therefore, this software should be treated as any other copyrighted material except that you may either: (1) make one copy of the Software for archival backup purposes, or (2) copy the Software to a single hard disk. If the Software is used on a networked computer system where more than one computer can access the Software provisions must be made to insure that the number of concurrently executing copies of the Software cannot exceed the number of licenses.

You may transfer the Software and all rights under this Agreement to another party together with a copy of this Agreement if the other party agrees to accept the terms and conditions of this Agreement. If you transfer the Software, you must at the same time either transfer all copies (including any prior versions) in any form to the same party or destroy any copies not transferred.

RESTRICTIONS

You may not use, disclose, copy, modify, rent, lease, loan, resell, network or transfer the Software, or any copy, modification or merged portion thereof, in whole or in part, except as expressly specified in this Agreement. You agree not to decompile, reverse engineer, disassemble or otherwise reduce the Software to a human perceivable form.

SOURCE CODE

If source code to the Software was supplied to you, then you may modify and use that source code in place of the executable version of the Software, but no further rights to distribution or use are granted.

TERM

This Agreement is effective until terminated. You may terminate it at any time by destroying the Software together with all copies, modifications and merged portions in any form. This Agreement will immediately and automatically terminate without notice if you fail to comply with any term or condition of this Agreement. You agree upon termination to promptly destroy the Software together with all copies in any form.

GOVERNMENT LICENSEE

If you are acquiring the Software on behalf of any unit or agency of the United States Government, the following provisions apply:

The Government acknowledges the licensor's representation that the Software and its documentation were developed at private expense and no part of them is in the public domain. The Government acknowledges the licensor's representation that the Software is "Restricted Computer Software" as that term is defined in Clause 52.227-19 of the Federal Acquisition Regulations (FAR) and is "Commercial Computer Software" as that term is defined in Subpart 227.471 of the Department of Defense Federal Acquisition Regulation Supplement (DFARS).

EXPORT LAW ASSURANCES

You acknowledge and agree that the Software is subject to restrictions and controls imposed by the United States Export Administration Act (the "Act") and the regulations thereunder. You agree and certify that neither the Software nor any direct product thereof is being or will be acquired, shipped, transferred or re-exported, directly or indirectly, into any country prohibited by the Act and the regulations thereunder or will be used for any purpose prohibited by the same.

GENERAL

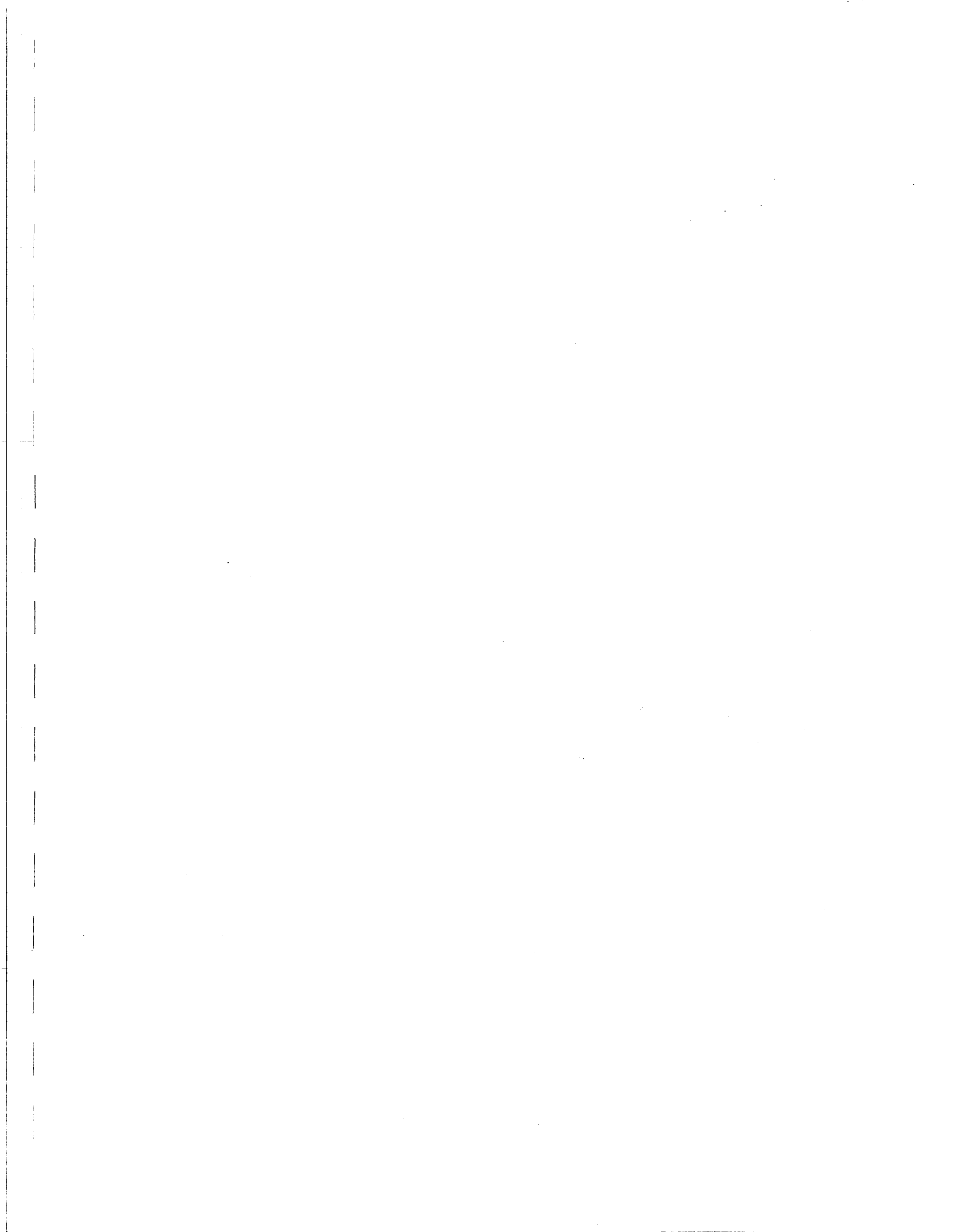
This Agreement will be governed by the laws of the State of California. You acknowledge that you have read this Agreement, understand it and agree to be bound by its terms and conditions. You further agree that it is the complete and exclusive statement of the agreement between us which supersedes any proposal or prior agreement, oral or written, and any other communications between us in relation to the subject matter of this Agreement.

Filmetrics, Inc. Limited Liability Statement

In no event will Filmetrics, Inc. be liable for any damages or expenses, including any lost profits, lost savings, or other incidental or consequential damages arising or associated with the use of, misuse of, or inability to use its products.

Table of Contents

Chapter 1	Introduction	1
Chapter 2	Installation	2
Chapter 3	System Overview	8
Chapter 4	Making Measurements	11
4.1	Types of Measurements	11
4.2	Examples	13
4.3	Measurement Assumptions	28
4.4	Hints for Improved Accuracy	28
4.5	Troubleshooting	30
Chapter 5	Details of Operation	32
5.1	Taking a Baseline	32
5.2	Editing Film Structures	32
5.3	Understanding and Evaluating Measurement Results	36
5.4	The File Menu	37
5.5	The Edit Menu	37
5.6	The Setup Menu	39
Chapter 6	How to Contact Us	42
Appendix A	Specifications	43
Appendix B	Theory of Operation	44
Appendix C	Optional Features	48
Appendix D	Light Bulb Replacement	49
Appendix E	Automation and Data I/O	50



Chapter 1 Introduction

What is the F20 used for?

The Filmetrics F20 is used to measure the thickness and optical constants (n and k) of transparent and semi-transparent thin films. Measured films must be optically smooth and between 100Å and 50 microns thick. Commonly measured films include semiconductor process films such as oxides, nitrides, resists, and polysilicon, optical coatings such as hardness and anti-reflection coatings, flat panel display films such as polyimides, resist, and cell gaps, and the various coatings used in CD and DVD manufacture. Films that can not be measured include very rough films and opaque films.

Who should read this manual?

Chapter 2 should be read by anyone setting up a system for the first time. First time users should also familiarize themselves with the FILMeasure software by reading Chapter 3, and then learn how to make measurements by following an example in Chapter 4. More detailed instructions on how to perform various functions are found in Chapter 5. Those interested in operation details can read the appendices, which provide background on measurement theory and hardware operation.

Chapter 2 Installation

The following steps assume that the F20 system, cables, and accessories have been unpacked and that you have a Pentium-based (100 MHz or greater) computer with a Windows 95/98/NT operating system and an available parallel port.

Step #1: Connect the F20 Spectrophotometer to the Computer

With the computer power off and the power cord to the F20 spectrophotometer unplugged, connect the F20 to the parallel port of the computer with the supplied cable.

Step #2: Connect power to the F20



Plug the F20 spectrophotometer into a 100-240 VAC ~ outlet with the supplied cable. Power to the light source is controlled by the front panel switch.

Step #3: Install software

If a computer was not supplied with the system then the software needs to be installed. Using the supplied installation disks, follow the instructions on Disk 1 of the installation disk to install the software on the computer.

Step #4: Test software

From the “Start” menu on the taskbar, select “Programs” and then select “FILMeasure” to begin program execution. If the program executes normally, proceed to step 5. If a “No Spectrometer Detected” message is issued and the power cord and interface cable are connected correctly, perform the following actions:

Perform the following actions only if the “No Spectrometer Detected” message is issued:

- a) Restart the computer and enter the CMOS setup. For a desktop computer system this is typically done by pressing the Delete key immediately after power up. For a notebook computer the setup is often entered by pressing F2 or F10.
- b) Find the part of the CMOS setup which deals with the parallel port (often this is found in a section called “Integrated Peripherals” or “Chipset Features”). Change the mode of the parallel port to ECP (other modes which may work are sometimes called SPP, BPP, EPP,

PS/2, or bi-directional). If there is an option dealing with whether the parallel port is reconfigurable or locked, select locked. The parallel port I/O base address must be one of the following: 378, 3BC, or 278. Save the changes and exit setup. Now try executing FILMeasure again.

- c) If the “No Spectrometer Detected” message reappears, try changing to one of the other modes listed above and executing FILMeasure again.
- d) If the “No Spectrometer Detected” message still appears after trying the above listed modes, the computer hardware is not compatible with the F20. If the computer is a desktop PC a plug-in parallel port card should be added. Plug the parallel port card into an open slot. After installing the parallel port card, try executing FILMeasure again.
- e) If none of these steps helps, contact Filmetrics for assistance.

Step #5: Connect Fiber-Optic Cable to the F20

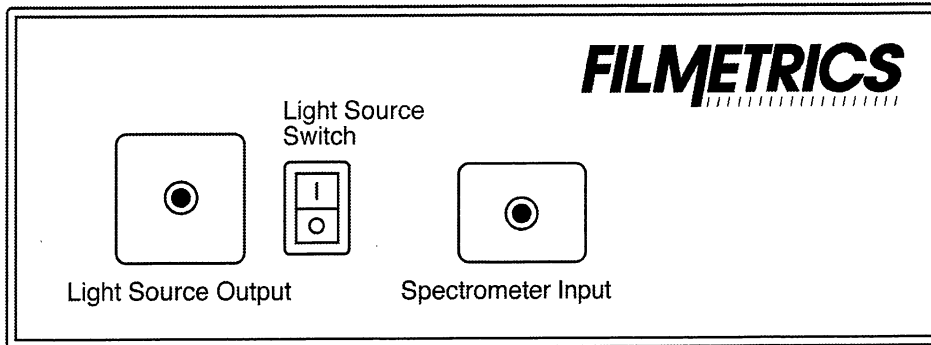


Figure 2.1: F20 Spectrometer/Light Source front panel

Follow the instructions on the following pages for setting up your particular measurement hardware:

If using fixed (SS-1) or rotating (WS-8, WS-12) sample stage:

Connect the fiber-optic reflection probe between the F20 front panel (illustrated in Fig. 2.1) and the stage as shown in Fig. 2.2. The reflection probe should be fully inserted into the arm on the stage. The screw on the end of the stage arm is actually a spring-loaded ball plunger, and does not require tightening.

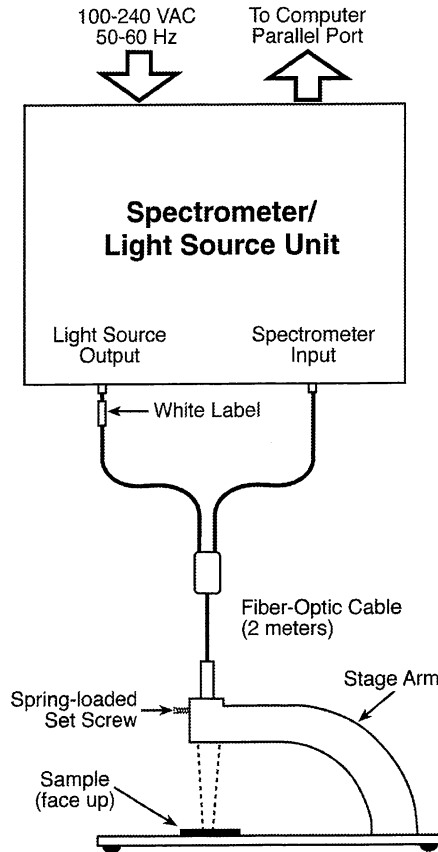


Figure 2.2: Setup Configuration for stage.

If using Contact Probe (CP-NIR):

Connect the Contact Probe to the F20 front panel (illustrated in Fig. 2.1) as shown in Fig. 2.3. The two fiber ends leading from the Contact Probe are identical, so they can each be attached to either the light source or spectrometer.

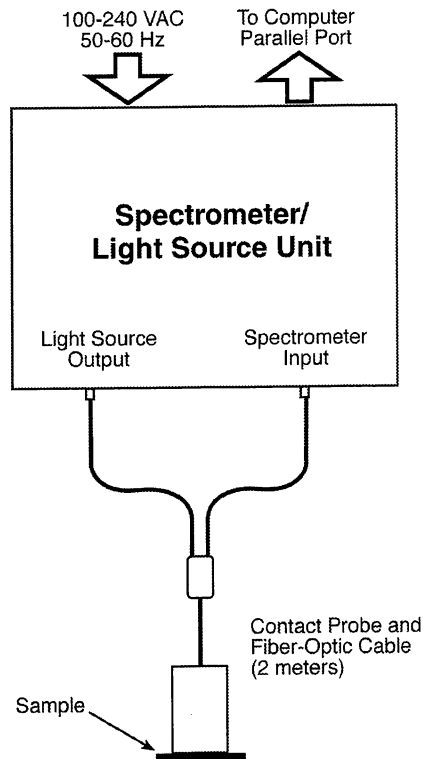


Figure 2.3: Setup Configuration for Contact Probe.

If using Contact Stage (SS-1 with CS-1 option):

Connect the Fiber Optic Contact Probe to the F20 front panel (illustrated in Fig. 2.1) as shown in Fig. 2.4. The two fiber ends leading from the Contact Probe are identical, so they can each be attached to either the light source or spectrometer. Connect the four 3" legs to the bottom of the SS-1 Sample Stage. Remove the tilted mirror insert in the SS-1 stage using a 1/16" hex socket driver. Screw the Fiber Optic Contact Probe common end into the black contact adapter, and then fully insert the contact adapter into the bottom hole in the SS-1 stage, fastening it with the 1/16" hex driver.

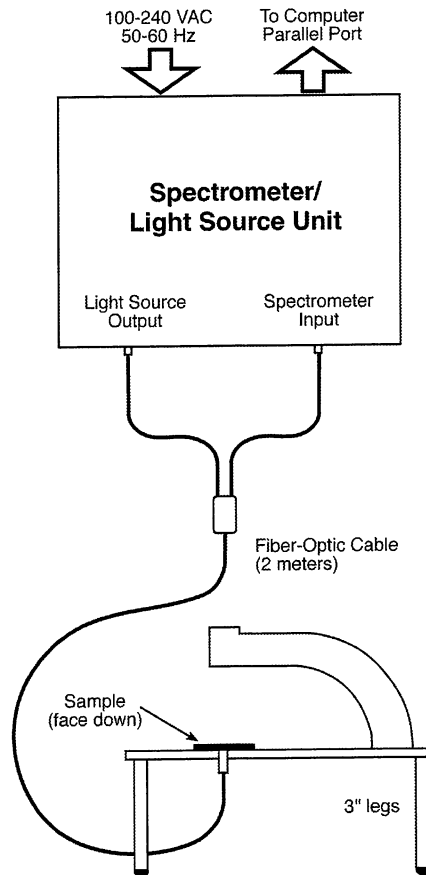


Figure 2.4: Setup Configuration for Contact Stage.

If using Transmission Option (SS-1 with T-1 option):

Connect the fiber-optic reflection probe between the F20 front panel (illustrated in Fig. 2.1) and the stage as shown in Fig. 2.5. The reflection probe should be fully inserted into the arm on the stage. The screw on the end of the stage arm is actually a spring-loaded ball plunger, and does not require tightening. Connect the four 3" legs to the bottom of the SS-1 Sample Stage. Remove the tilted mirror insert in the SS-1 stage using a 1/16" hex socket driver. Screw one end of the single fiber optic cable into the black adapter, and then fully insert the adapter into the bottom hole in the SS-1 stage, fastening it with the 1/16" hex driver.

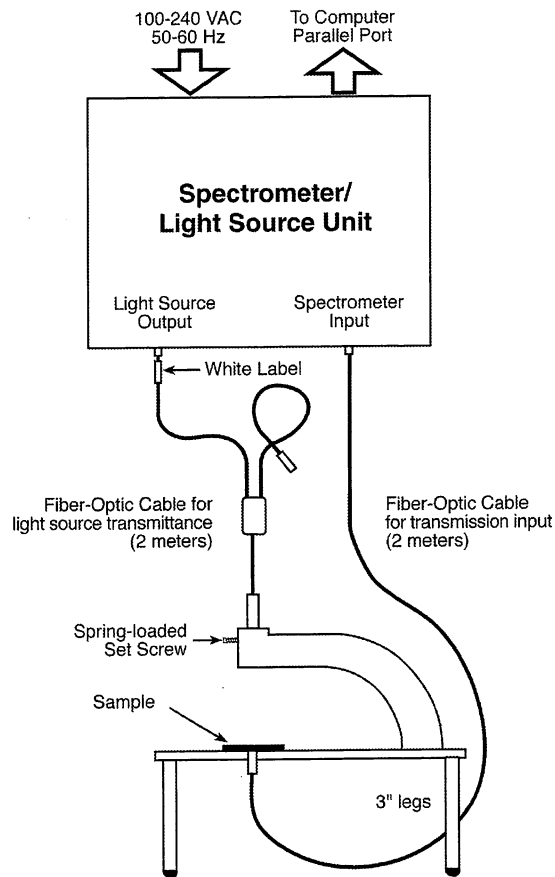
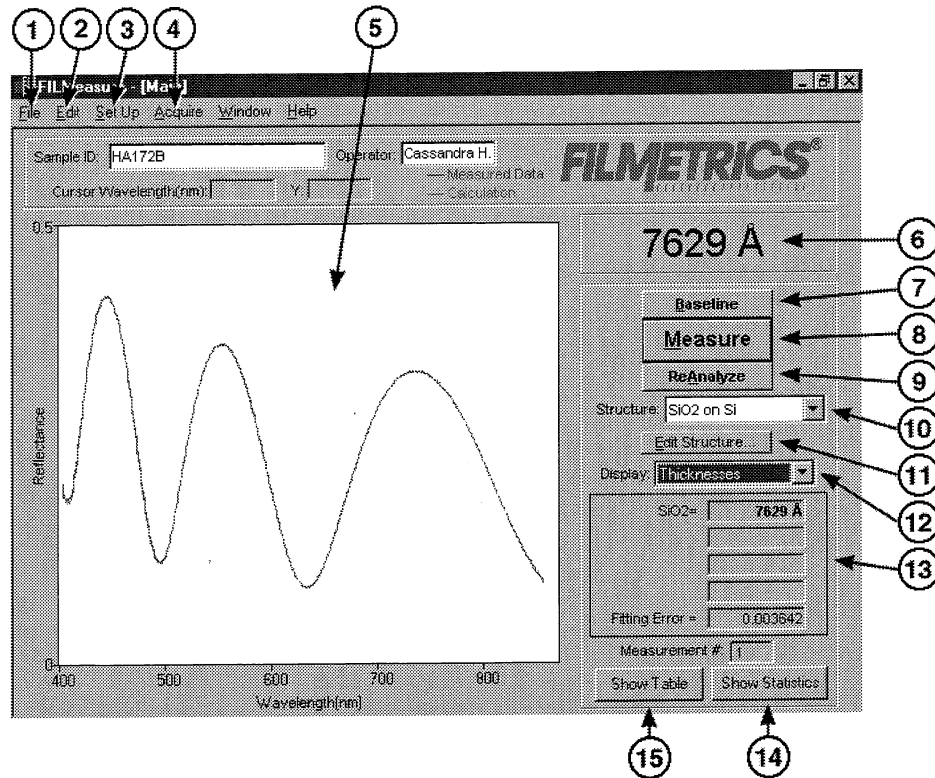


Figure 2.5: Setup configuration for T-1 transmission option.

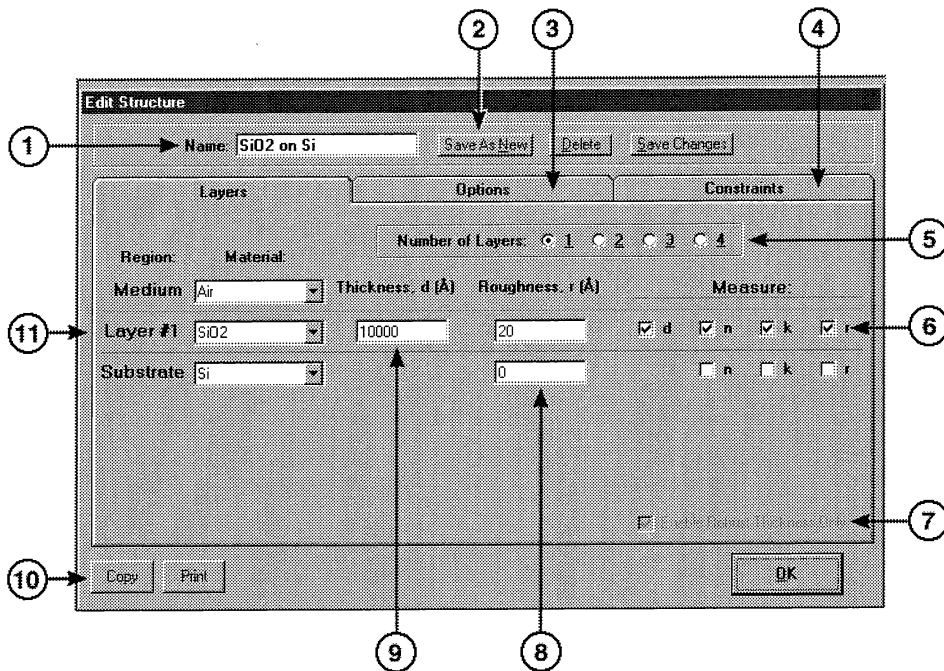
The way that light reflects off of a thin film is determined by the characteristics of the film, such as its thickness, optical constants, and roughness. The F20 is able to determine thin-film characteristics by first carefully measuring the amount of light reflected from the thin film over a range of wavelengths (i.e., by measuring the reflectance spectrum), and then analyzing this data by comparing it to a series of calculated reflectance spectra. Most of the features of the FILMeasure software that runs the F20 can be divided into reflectance acquisition and reflectance analysis functions. The following pages outline the main features of the FILMeasure software.

FILMeasure Main Window



1. Standard Windows File menu for saving and retrieving data, printing, etc.
2. The Edit menu is used for copying measured spectra and measurement results, as well as selecting thickness units and editing the material library.
3. Used to setup reflectance acquisition parameters and the graphic display.
4. For starting and stopping continuous reflectance acquisition. Convenient for setting up hardware.
5. Graphical display for measured and calculated reflectance, as well as measured optical constants. Change display limits by double-clicking in the display area.
6. The measured film thickness is displayed here.
7. The baseline measurement sequence, which is required before measurements are made, is initiated by pressing the Baseline button.
8. This button causes a reflectance spectrum to be acquired and then analyzed in one step.
9. Analysis only on the displayed reflectance spectrum. Usually used when trying different analysis settings on a previously acquired spectrum.
10. Used to select the film structure that is to be measured.
11. This is where the selected film structure is described, and the analysis parameters are set.
12. Used to select the information displayed in the Results Box below.
13. The Results Box summarizes the most recent measurement results.
14. Statistical tabulation of all measurement results are accessed by pushing this button.
15. Complete results of the most recent measurement are accessed by pushing this button.

Edit Structure Window



A structure defines the film to be measured, the substrate and any underlying films, the approximate thickness of the film, and the quantities to be measured:

1. The name of the film structure is listed/edited here.
2. The structure can be saved as a new structure, deleted, or changes can be saved.
3. Advanced measurement parameters can be accessed by clicking on the Options tab.
4. Constraints on the possible measured values are selected here.
5. The number of film layers is chosen here.
6. The values to be measured are selected by checking the appropriate boxes.
7. A very robust thickness measurement routine is enabled by selecting this box.
8. Known film roughness for films not being measured, and the initial guess for the film(s) being measured are entered in this column.
9. Known film thicknesses for films not being measured, and the initial guess for the film(s) being measured are entered here.
10. All of the Edit Structure parameters can be copied or printed. This is convenient for remembering temporary setups, setting up multiple F20s, or sending measurement parameters to Filmetrics for troubleshooting.
11. The film layers are listed here. Common films can be selected from the pull-down menus.