Tips for first-time users of the Power Sensor Support Package

This document offers some tips for anyone using the SureCAL Power Sensor Support Package for the first time. It is divided into four sections, "What You Need", "Questions to Ask Yourself", "Things to Look For" and "Answers to Frequently Asked Questions"

WHAT YOU NEED:

If you want to experiment with the software without running actual tests with hardware, you need:

- A Pentium-based PC or laptop with a IEEE-488 interface card and cable.
- Version 5.0 of Test Manager Lite or higher
- The Power Sensor Support Package

If you want to run an actual calibration using hardware, you'll need more:

- A common power sensor to test. (recommend HP 8481A)
- A power meter to use with the sensor (recommend HP 436A or 437B)
- A STANDARD power sensor (recommend TEGAM 1807 or F1109)
- Calibration Data (Cal Factors with 2-Sigma Uncertainties) for the above standard
- A STANDARD power meter (recommend TEGAM 1805A)
- A microwave synthesizer (recommend HP 8340A or 83630A)

Other equipment may be substituted for the "recommended" models above.

QUESTIONS TO ASK YOURSELF:

Q.   How do you calibrate power sensors now?

If you already calibrate some of your own sensors, you will already understand "how it is done" and will have existing hardware you will want to continue using. Rest assured that your current hardware will most likely be supported by SureCAL. If you do not calibrate your own sensors already, you may be worried about the cost of new hardware, but the software's flexibility allows you many options for configuring a test system. You may need to buy less equipment (or less expensive equipment) than you think.

Q.   If you calibrate your own, what standards do you use?

Most likely, you are using one of two systems: a Weinschel System II or an HP 11760S. Users of either system are probably looking to replace their software to obtain the ability to calibrate newer sensors or allow them to use a Windows based computer. The SureCAL Power Sensor Support Package will work with the hardware from either of these two systems. If you are using the Weinschel system, the default Test Profiles in the SureCAL software are ready to go. If you are using the HP 11760S system, the Test Profiles will have to be modified to use that hardware. (This is something you would have to setup only once.)

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Q.   What sensors do you need to calibrate?

The SureCAL Power Sensor Support Package includes complete procedures for the following sensors: Anritsu MA2469A, Boonton 4200-4E, 57318, 57518, Giga-tronics 16936, 17266, 80301A, 80321A, 80350A, Hewlett Packard 11722A, 11792A, 478A, 8478B, 84812A, 84815A, 8481A, 8481B, 8481D, 8481H, 8482A, 8482B, 8482H, 8485A, 8485D, E4412A, E4413A, TEGAM / Weinschel 1807A, F1109, F1116, F1117A, F1119 and Wavetek 13869. In addition to these, the software recognizes over 100 other sensors, and new sensor definitions can be added.

Q.   What sensor would you like to try first?

If you don't have a specific one in mind, we recommend something simple, like a HP 8481A. Try to avoid high power or low frequency sensors for first-time trials. Those procedures require more hook up changes and will take considerably longer to run. Keep it as simple as possible for your first sensor.

THINGS TO LOOK FOR:

- The Power Sensor Support Package was the first of a new class of SureCAL products. It was the first product to bundle multiple procedures, 32 in all, for one price. It is the first procedure to use Test Profiles, which give you unprecedented flexibility in controlling the test parameters.

- To begin, launch Test Manager and load any of the 32 sample procedures. (We recommend the HP 8481A for first-time users.) Once the procedure is loaded, take some time to explore the pull-down menus and toolbar buttons, if you are not already familiar with them.

- Go directly to the "CAL FACTORS" procedure step, then click on the button on the Toolbar. This button allows you to access the Test Profile. You will be prompted to enter a password. Type in the password "SURECAL" (capital letters!). The password is provided to control who has access to the test parameters. You can change it to whatever you like.

- Get acquainted with the Test Profile editing screen, exploring each of the Test Profile Tabs, decribed below:

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Test Profile – General Tab

This tab displays a general description of the test to be performed. The "Comments" text may be edited simply by clicking on it. To select a different Test Profile, click on the "Select" button on the right hand side of the screen. This will display a list of all previously defined Test Profiles, including all 32 of the Default Profiles, plus any Custom Profiles that have been created from them.

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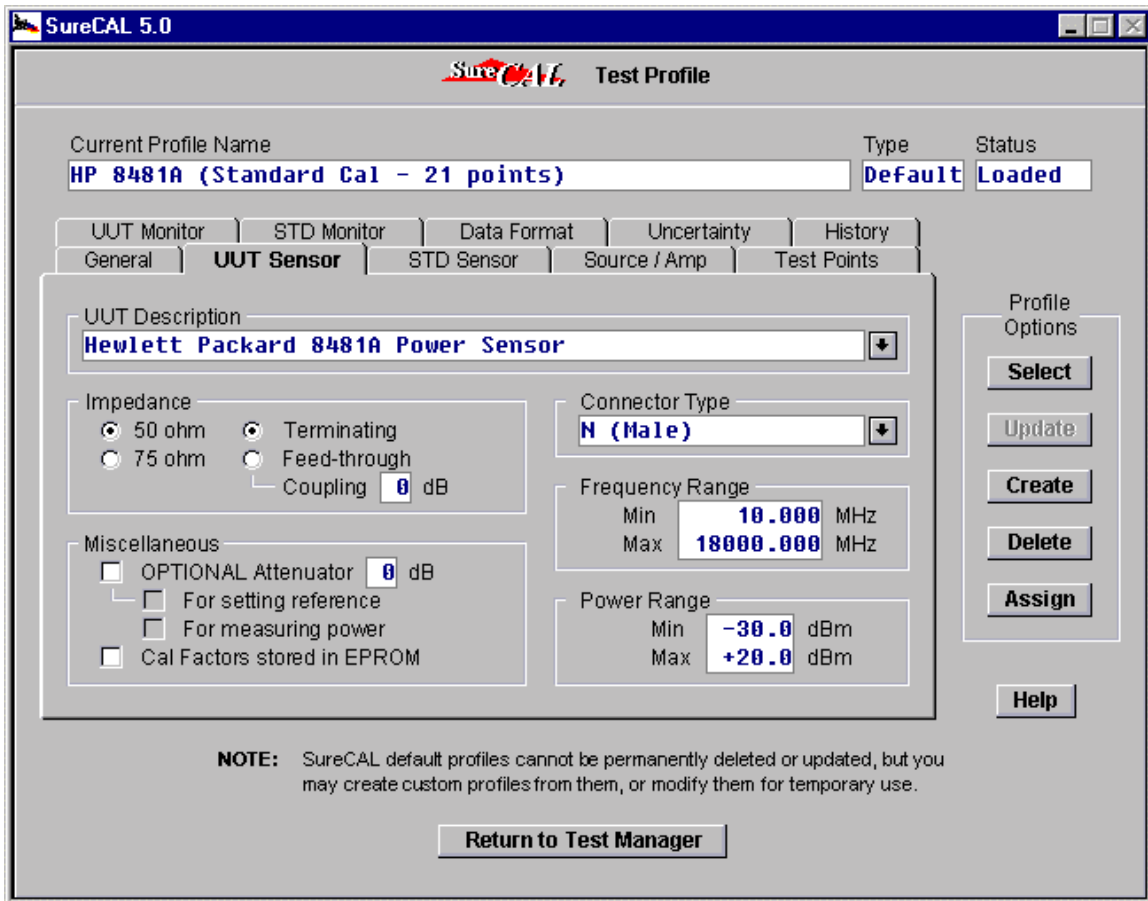**Test Profile – UUT Sensor Tab**

This tab describes the Unit Under Test. Note the generic nature of the sensor description. Virtually any power sensor can be described on this screen.

Click on the ⬇ button to the right of the "Connector Type" field to display a picklist of over 30 different RF connectors. The software knows which connectors can mate safely and will give specific warnings if you try to mate connectors which could damage each other. You may add to the list of connectors.

Next, click on the ⬇ button to the right of the "UUT Description" field and view a picklist of 150 predefined sensors to choose from. You can add to this list also.
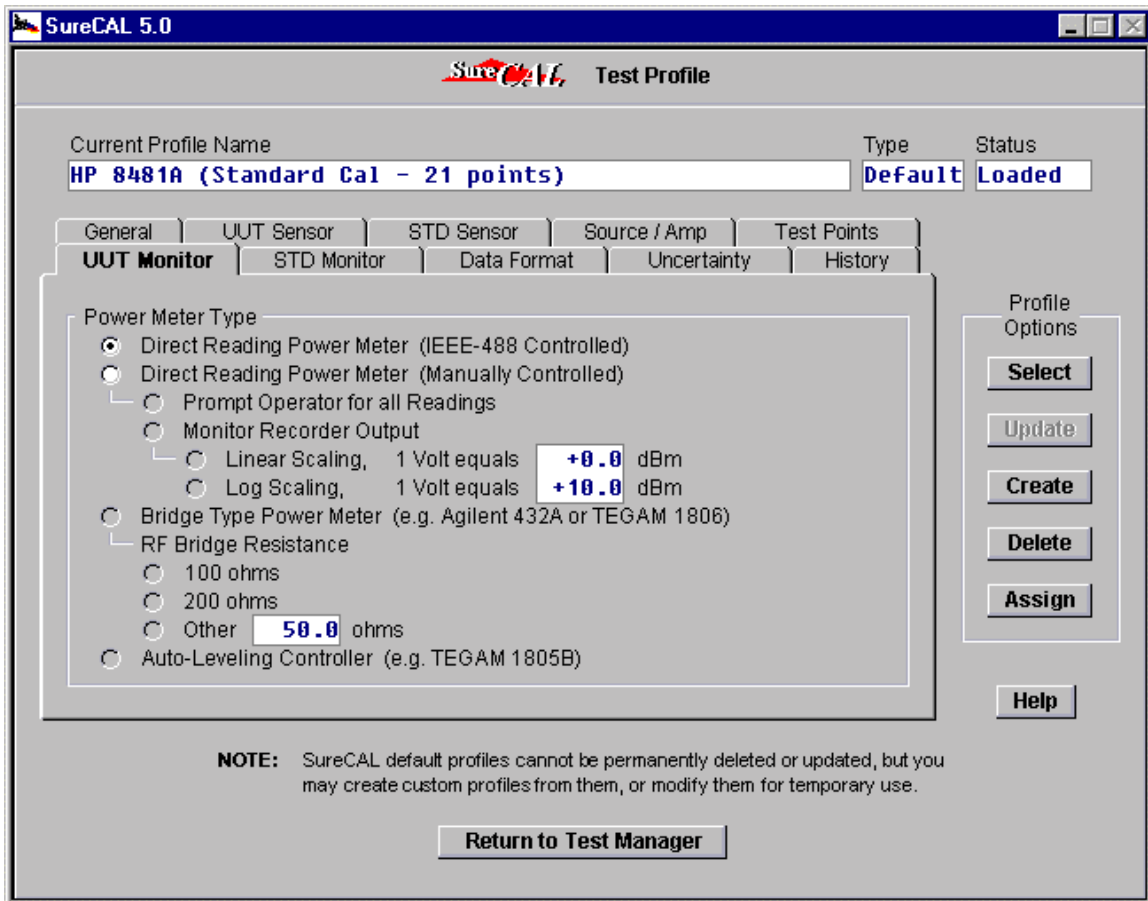
Test Profile – STD Sensor Tab

This tab describes the Standard Sensor. This screen is **identical** to the "UUT Sensor" tab. The software is designed to be generic. It can compare any power sensor to any other power sensor, provided that one of them is a "terminating" type and the other one connects to a power splitter or coupler – what the software refers to as a "Feed-through" type. In the picklist of 150 predefined sensors, many of the selections will say, "w/ Splitter", signifying that they are the "Feed-through" type sensors.

Test Profile – UUT Monitor and STD Monitor Tabs

These two tabs are also identical and describe the type of power meters used to monitor the UUT and STD Sensors respectively. Four types of monitor are supported:

1) **Direct Reading, IEEE controlled** Use this type if there is a SureCAL Driver for the meter you want to use.

2) **Direct Reading, Manually controlled** Use this type for meters that have no IEEE interface or have a "Recorder Output" which generates a voltage proportional to the power reading. If monitoring a Recorder Output, you will need a Digital Voltmeter with a SureCAL Driver. You also need to specify the scaling of the output voltage in the fields provided.

3) **Bridge Type** If you're not familiar with this type, it's just like a HP 432A or Weinschel 1806 meter. Both have a "VRF" output voltage, monitored by a DMM. This voltage is measured directly across an RF bridge circuit and is not scaled like a Recorder Output. The nominal bridge impedance must be specified to use this type.

4) **Auto-Leveling Controller** If you aren't currently using a Weinschel System II, this option won't mean anything to you. It is used exclusively for the TEGAM / Weinschel 1805A.

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Test Profile – Source/Amp Tab

This screen allows you to specify the use of one or two signal sources and the frequency to switch from one to the other. If high power test levels are required, two amplifiers can also be defined.

If you are currently using the HP 11760S system, you can still use your automatic signal routing switch by clicking on the last checkbox. If you are using the Weinschel System II and have an accessory 1727A amplifier / switching unit, that is also supported.

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Test Profile – Test Points Tab

This tab allows you to specify any test frequencies you require and the nominal test level. The frequencies are limited only by the capability of your RF Source(s) and the calibrated range of your Standard Sensor.

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║ ▨ SureCAL 5.0                                                      _ □ ✕        ║
╠══════════════════════════════════════════════════════════════════════════════╣
║                    Sure CAL   Test Profile                                     ║
║                                                                                ║
║   Current Profile Name                                  Type      Status       ║
║   HP 8481A (Standard Cal - 21 points)                  Default   Loaded        ║
║                                                                                ║
║   ┌ UUT Monitor ┐┌ STD Monitor ┐┌ Data Format ┐┌ Uncertainty ┐┌ History ┐     ║
║   ┌ General ┐┌ UUT Sensor ┐┌ STD Sensor ┐┌ Source / Amp ┐┌ Test Points ┐      ║
║                                                                    Profile      ║
║                                                                    Options      ║
║   Nominal Test Level   +0.000  dBm              Additional                     ║
║                                                 Freqs (MHz)       [ Select ]    ║
║   ☑ Reference Frequency     50.000  MHz      ☑     10.000                       ║
║                                              ☑    500.000         [ Update ]    ║
║        Start (MHz)   Stop (MHz)   Step (MHz) ☐      0.000                       ║
║   ☑   1000.000     18000.000     1000.000    ☐      0.000         [ Create ]    ║
║   ☐      0.000         0.000         0.000   ☐      0.000                       ║
║   ☐      0.000         0.000         0.000   ☐      0.000         [ Delete ]    ║
║   ☐      0.000         0.000         0.000   ☐      0.000                       ║
║   ☐      0.000         0.000         0.000   ☐      0.000         [ Assign ]    ║
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║   ☐      0.000         0.000         0.000   ☐      0.000         [ Help ]      ║
║                                                                                ║
║     NOTE:   SureCAL default profiles cannot be permanently deleted or updated, ║
║             but you may create custom profiles from them, or modify them for   ║
║             temporary use.                                                     ║
║                                                                                ║
║                        [ Return to Test Manager ]                              ║
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Test Profile – Data Format Tab

This tab allows you to specify how test data is reported. Calibration Factors can be reported in "dB" or "%" units. The optional Reference Cal Factor can be specified or limited by specific guidelines. To support older power meters which set their cal factor corrections with a mechanical switch, the reference can be forced to 1% or 0.1dB increments. To support power meters with a limited range of valid cal factors, those limits can be specified. If no limits are specified, the cal factor graph will automatically scale itself to display whatever data is measured.

If you want to report "Effective Efficiency" in addition to Cal Factor, this can be selected as well. You must have manually entered the UUT Sensor's SWR data into it's history data file to make use of this last option.

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Test Profile – Uncertainty Tab

This tab allows you to choose how measurement uncertainties are reported on your Calibration Record. Two options are provided. Uncertainties may be expressed at a one-sigma level (combined standard uncertainty, 68% confidence) or a two-sigma level (expanded uncertainty, 95% confidence). Both methods conform to the methodology described by the ISO Guide to the Expression of Uncertainty in Measurement.

If previous data is available for the UUT, you may also opt to FAIL the sensor if the Cal Factors have changed by more than the reported uncertainty.

To include actual (not estimated) repeatability measurements in the uncertainty budget, the final checkbox can be employed to loop the test for a specified number of connect-disconnect cycles.

Dynamic Uncertainty Budgets

Due of the inherent flexibility of the Power Sensor Support Package, it would be impossible to "hard-code" enough uncertainty budgets to satify all potential test configurations. Therefore, dynamic uncertainty budgets are generated at runtime, based on the actual equipment used, current test parameters and available data.

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Dynamic uncertainty budgets may include the following components as applicable:

Type A Components:

- Connect-Disconnect Repeatability (Type A or B depending on profile)
- UUT Power Meter Stability (std deviation of the mean of 5 readings)
- UUT Power Monitor Voltmeter Stability (std deviation of the mean of 5 readings)
- STD Power Meter Stability (std deviation of the mean of 5 readings)
- STD Power Monitor Voltmeter Stability (std deviation of the mean of 5 readings)

Type B Components:

- Connect-Disconnect Repeatability (Type A or B depending on profile)
- STD Sensor's Cal Factor Uncertainty (obtained from data file)
- Attenuator Correction Uncertainty (obtained from data file)
- Adapter Correction Uncertainty (obtained from data file)
- Min Loss Pad Correction Uncertainty (obtained from data file)
- UUT Power Meter Linearity (defaults to 0.2%)
- UUT Power Meter Absolute Reference Uncertainty (defaults to 1.2%)
- UUT Power Monitor Voltmeter Uncertainty (obtained from voltmeter driver)
- UUT Power Monitor Bridge Uncertainty (defaults to 0.2%)
- UUT Power Monitor Bridge Balance Stability (1805B only, 0.03%)
- UUT Power Monitor DC Substitution Uncertainty (1805B only, 0.5%)
- STD Power Meter Linearity (defaults to 0.2%)
- STD Power Meter Absolute Reference Uncertainty (defaults to 1.2%)
- STD Power Monitor Voltmeter Uncertainty (obtained from voltmeter driver)
- STD Power Monitor Bridge Uncertainty (defaults to 0.2%)
- STD Power Monitor Bridge Balance Stability (1805B only, 0.03%)
- STD Power Monitor DC Substitution Uncertainty (1805B only, 0.5%)
- Test Port to Adapter Mismatch (calculated from available data)
- Adapter to Attenuator Mismatch (calculated from available data)
- Test Port to Attenuator Mismatch (calculated from available data)
- Adapter to Min Loss Pad Mismatch (calculated from available data)
- Test Port to Min Loss Pad Mismatch (calculated from available data)
- Min Loss Pad to UUT Mismatch (calculated from available data)
- Attenuator to UUT Mismatch (calculated from available data)
- Adapter to UUT Mismatch (calculated from available data)
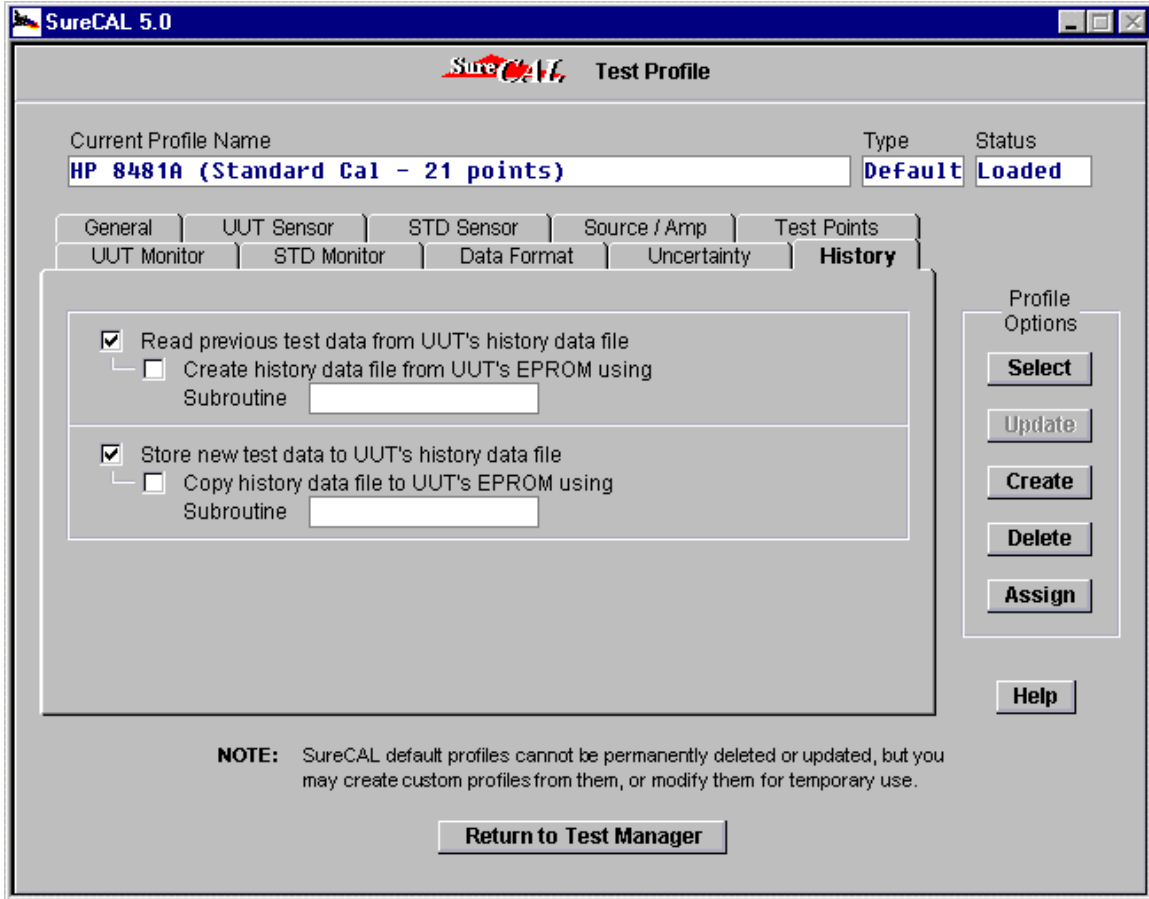- Test Port to UUT Mismatch (calculated from available data)

Type B components for the STD Sensor's Cal Factor Uncertainty, Attenuator Correction Uncertainty, Adapter Correction Uncertainty and Min Loss Pad Correction Uncertainty are doubled (and given Rectangular distribution) if frequency interpolation is required.

Type B components for mismatch are based on available information. If all four S-Parameters are available for a given connection, the actual mismatch is calculated and removed from the measurement. In this case, a "Residual" mismatch uncertainty component is recorded. If only partial S-Parameter data is available (e.g., magnitudes only), an estimate is made from those numbers. If no magnitude data is available for a connector, it is assumed to have a reflection coefficient of 0.09. (approx. 1.20 SWR).

Type A components are assumed to have Normal distribution. Non-interpolated components obtained from an "UNCERTAINTY" column in a SureCAL data file are also expected to have Normal distribution, with a coverage factor of 2. All Mismatch components are assumed to have U-shaped distribution. All other components are assumed to have Rectangular distribution.

Test Profile – History Tab

This tab is used primarily to specify custom routines for downloading and uploading EPROM data from/to a UUT sensor. This feature allows the software to be expanded in the future as new EPROM sensors become available.

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Managing Test Profiles

Any number of predefined Test Profiles may exist, each identified by its own unique name. The current profile name is displayed at the top of the profile editing screen.

PROFILE TYPES AND USES:

Test Profiles come in two types: Default and Custom. Default Profiles are provided by SureCAL and are always available, although you don't have to use them. Custom Profiles are modified versions of the SureCAL defaults, which have been saved under their own unique names by the customer.

Profiles may be loaded automatically based on various assignment criteria, or they may be manually selected from a pick list. Once loaded, profiles may be used as-is or modified for temporary use. Any profile may be modified to create a new Custom Profile and existing Custom Profiles may be modified, updated or deleted. SureCAL Default Profiles may not be deleted.

SELECTING A NEW PROFILE:

To select a new profile, press the 'Select' button. A pick list of ALL previously defined Test Profiles will be displayed. When viewing this list, note that both Default and Custom Profiles are shown. Also note that the Assignment Status of each profile is shown. If a profile is marked as "Assigned", it will be loaded automatically if certain criteria are met. Otherwise, profiles will be marked as "Floating". A floating profile will never be automatically loaded, it must be manually selected from this list.

MODIFYING A PROFILE:

Once a new profile has been loaded, it will show its Status as 'Loaded'. If any modifications are made to specific profile settings, the Status will change from 'Loaded' to 'Modified'. Modifications may be made by simply editing the various tabs that describe the test parameters. Whatever the status of these tabs, they are the current settings that will be used when you return to Test Manager.

SAVING CHANGES or CREATING CUSTOM PROFILES:

If you have modified a Test Profile and wish to save the settings permanently, you have two options. You may Update modified Custom Profiles or you may Create entirely new Custom Profiles. Default Profiles may not be updated, so if you want to save a modified Default Profile, you must create a Custom Profile from it.

To Update a modified Custom Profile, press the 'Update' key. This key is only available for modified Custom Profiles.

To create a new Custom Profile from the current profile settings, press the 'Create' key. You will be prompted to enter a new unique profile name.

DELETING CUSTOM PROFILES:

To delete one or more Custom Profiles, press 'Delete'. A pick list of all Custom Profiles (except the current profile, if applicable) will be displayed. You may highlight any or all of these entries. When all the desired profiles are highlighted, press 'OK' to delete them. Note that Default Profiles and the current profile may not be deleted.

CHANGING PROFILE ASSIGNMENT STATUS:

Any profile may be configured to automatically load when certain assignment criteria are met, or they may designated as 'Floating'. To view or edit the assignment rules, press the 'Assign' button.

When configured to automatically load, profiles are assigned by a combination of the CP File name and the current Procedure Step Title (e.g., 'CP0196' + 'CAL FACTORS'). An optional, secondary assignment parameter may also be specified. This parameter may be any one of the following: UUT Ident Number, UUT Serial Number, UUT Model Number or UUT Description. This allows multiple profiles to be assigned to a given CP File and Step Title. Different profiles can be specified for individual UUT Ident Numbers, Models, etc., and they will be loaded automatically when the assignment criteria matches.

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- **Before You Run an Actual Test**

Be sure to assign Flexible Standards ![icon] before running the test. Not all Generic Names listed will be used. If there is no LOW FREQ SOURCE or AMPLIFIER / SWITCH required, these entries should be "* Not Assigned *" Normally, POWER MONITOR #1 is assigned to the Standard Sensor's power meter and POWER MONITOR #2 is assigned to the UUT Sensor's power meter. A DMM may be substituted if the meter is not the "Direct Reading IEEE Controlled" type.

After setting up flexible standards, press the SPACEBAR to begin. A summary screen of your Test Profile will be displayed. Double-check the information to make sure everything is right, then click "OK".

The software will request a Data File entry for the Standard Sensor. The file TRANSFER.DAT can be used for demo purposes, but it will not have the correct data in it for your standard. Edit this file ahead of time using NOTEPAD to enter valid cal factors and make sure the Expiration Date has not passed. Rename the file to identify it with your Standard Sensor.

The software will next request a Data File for the UUT. You may choose "Proceed Without Data" for the UUT. These data file requests will only happen the FIRST time you run the test or after you have modified a test profile. If you want to alter either selection before subsequent runs, click on ![icon].

Next, the program will draw the hook-up for the "Feed-through" sensor (This is normally the Standard), then the hook-up for the "Terminating" sensor (This is normally the UUT). Connect the Standard and UUT sensors together as instructed. The program will begin testing and draw a graph on the screen.

When the test is complete, the program will ask if you want to update the UUT Sensor's data file. Answer "Yes" and a file will be created. After the test finishes, you may view the results by clicking on ![icon].

ANSWERS TO FREQUENTLY ASKED QUESTIONS:

Q.   Can the program print labels?

A.   Yes. Labels with CAL FACTORS can be printed to one of the computer's local printer
        ports. It must not be the same printer used for datasheet printouts. The SureCAL
        program uses a preset format for label printing, but a Basic Language routine can be
        modified to override the default format.

Q.   Does the software work with an HP 8510 Network Analyzer?

A.   No. Not yet. The SWR portion of the power sensor test uses an HP 8757 Scalar
        Network Analyzer manually. SureCAL is currently developing a new product called the
        RF Component Support Package, which will allow automated data collection using an HP
        8510.

Q.   Does the software use vector impedance data to compensate for mismatch?

A.   Yes it can, but only if you manually enter the vector impedance data into the UUT and
        STD Sensor data files. If the data is present, it will be used and the uncertainty budget
        will be updated accordingly.

Q.   How long does it take to calibrate a sensor?

A.   This will depend on how many hook-up changes are required and how many frequency
        points are tested, but a typical 8481A sensor can usually be calibrated in under 10
        minutes.