FLUKE ®

Hart Scientific ®

9950

SensorCal
User's Guide

Rev. 611101

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1 Introduction

The Model 9950 SensorCal Automated Temperature/Humidity Calibration system (SensorCal) automates the calibration of Hart Model 2626-x temperature/humidity sensors for the Hart Model 1620 "DewK" Thermohygrometer. This system requires the use of specific test equipment and the SensorCal software. Basic information regarding the test equipment requirements and settings are described in the following sections of this User Guide. Setup, configuration, and use of the SensorCal software are also described.

1.1 Conventions

Throughout the SensorCal software and this User's Guide, the following conventions are observed.

- The words "sensor" and "probe" are used interchangeably.

- The term "unit under test", along with the acronym "UUT", refers to a sensor that is being calibrated.

- The words "test" and "calibration" are used interchangeably and refer to the process of taking data from and/or calculating constants for sensors.

- The words "constants" and "coefficients" may be used interchangeably and refer to calculated characterization values belonging to a sensor that are used to assist a readout device to correctly display readings from that sensor.

- The word "alignment" refers to the process of calculating the characterization coefficients of a sensor and/or programming the coefficients into the sensor.

- The term "local database" refers to a database on the local computer where test results are stored temporarily, while a calibration is being performed.

- The terms "network database" and "archive database" are used interchangeably and refer to the database where test results are permanently stored.

- The terms "User's Guide", "Owner's Manual", and "Operation and Maintenance Manual" are used interchangeably.

1.2 Safety Information

Use this system only as specified in this manual. Refer to the User's Guide for each instrument for more detailed information on the proper use of each instrument. Refer to the safety information in WARNINGS and CAUTIONS sections. The following definitions apply to the terms "WARNING" and "CAUTION".

- "WARNING" identifies conditions and actions that may pose hazards to the user.
- "CAUTION" identifies conditions, settings, and/or actions that may adversely affect the results of the calibration process if not understood and used in an appropriate manner.

1.2.1 ⚠ WARNINGS

To avoid possible electrical shock or personal injury, follow these guidelines.

GENERAL

- **DO NOT** use the system for any application other than the calibration work for which it is intended. The system was designed for temperature and humidity calibration. Any other use of the system may cause unknown hazards to the user.
- **DO NOT** use the system or any of the system's instruments in environments other than those listed in the owner's manuals.
- Follow all safety guidelines listed in this and each instrument's owner's manual.
- Calibration Equipment should only be used by trained personnel.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- The system is intended for indoor use only.

ELECTRICAL HAZARD

- Each instrument must be plugged into a 120V AC electric outlet of the appropriate frequency. The power cord of each instrument must be plugged directly into a properly grounded receptacle or power strip. The receptacle must be installed in accordance with local codes and ordinances. Consult a qualified electrician.
- Always replace the power cord with an approved cord of the correct rating and type. If you have questions, contact an Authorized Service Center.
- High voltage is used in the operation of this equipment. Severe injury or death may result if personnel fail to observe the safety precautions. Before working inside the equipment, turn off the power and disconnect the power cord.

1.3 Authorized Service Centers

Please contact <u>only</u> the following authorized Service Center to coordinate service on your system:

Fluke Corporation, Hart Scientific Division

799 E. Utah Valley Drive

American Fork, UT 84003-9775

USA

Phone: +1.801.763.1600

Telefax: +1.801.763.1010

E-mail: support@hartscientific.com

When contacting the Service Center for support, please have the following information available:

- Name and/or model number of the system (Model 9950 SensorCal System)
- Model number of instrument (if applicable)
- Serial number of instrument (if applicable)
- Complete description of the problem, including the **exact** wording of any error messages given by the software
- Details of what task or operation was being performed when the problem arose
- Any other information that may be pertinent to assist in resolving the issue

1.4   Requirements

This system is designed to use specific instruments to perform the temperature/humidity calibrations. Use of any test equipment, computer system, software, or conditions other than those outlined in this section is not supported and may invalidate the calibration process.

Use of this system does not provide a guarantee of any specific measurement uncertainties. It is the sole responsibility of the user of this system to calculate the uncertainties being achieved by the system in its specific implementation. Prior to purchasing this system, a letter must be signed indicating the user(s) of this system understand and accept this responsibility. The user's failure to sign this letter does not implicate Hart as being responsible for the uncertainties achieved by the system.

The following sections outline the basic requirements of this system. For more detailed information regarding the test equipment configuration and requirements, refer to Section 5, Test Equipment Configuration.

1.4.1   Computer

The minimum recommended computer specifications required by this system are described in Table 1. The computer is provided as a part of this system.

Table 1   *Recommended computer requirements*

Item	Recommendation
Processor	Pentium 4, 2.0GHz or better
Memory	256MB or better
Video Resolution	1024 x 768 pixels or better
CD/DVD Drive	CD-ROM or DVD drive required for installation
Hard Drive	10 GB or better (40 MB minimum free space required for installation; more space required as tests are performed)
Floppy Drive	Not required
COM Ports	2 COM ports required – can use USB adapters if needed (IOGear® Model GUC232A recommended)
Expansion Slots	One PCI expansion slot or one Type II PC Card slot available (for GPIB IEEE-488 card)
Operating System	Windows® 2000/XP required
Network	Recommended, not required
GPIB IEEE-488 Interface	National Instruments PCI-GPIB or PCMCIA-GPIB card and Measurement and Automation Explorer software required
Printer	Laser or inkjet printer recommended (local or network)
Power strip	Surge protector recommended

1.4.2   Computer Configuration and Settings

The computer provided has already been configured for use with SensorCal. This section details the selections made during the installation of the Windows® XP Professional operating system on the computer and indicates any changes that were made to the default installation.

Computer Name and Network Settings

- The PC is setup as a stand-alone system (not joined to a domain)
- The computer name is set to *SensorCal1* with a description of *SensorCal Test Station 1*

Login Account Settings

- The local administrator account is setup with the username *Administrator* and password *Administrator*
- An additional local user account has been setup with the username *SensorCal* and password *SensorCal* as a member of the *Power Users* group

Basic Configuration Settings

- The BIOS settings for *AC Power Failure* have been set to *On* (to allow the computer to automatically reboot after a power failure)
- The *Regional Options* are set to *US\English* using a *US\English keyboard*
- The *Time Zone* is setup for *Mountain Standard Time* with the *Daylight Savings* option enabled
- No printer drivers have been installed
- Windows® has been configured to automatically logon using the *SensorCal* user account

Hardware and Software Configuration

- The Windows® operating system has already been activated
- No anti-virus software has been installed
- The Windows® Security Center alerts have been disabled
- The Windows® firewall settings have not been changed from their default settings
- No additional Service Packs or Windows® Updates have been installed
- The *Windows® Automatic Updates* feature is turned off
- The *SensorCal* software has been installed
- A shortcut to *SensorCal* has been added to the *Startup* program group to automatically run *SensorCal* when logging on to Windows®
- The National Instruments *Measurement and Automation Explorer* (MAX) software has been installed
- A National Instruments GPIB card has been installed
- For computers with one or no RS-232 ports, either one or two IOGear USB to RS-232 adapters have been installed

As mentioned, two user accounts have been created on the PC. Windows® requires an administrator account to be created during operating system installation. As such, a local administrator account is setup on the PC with the username *Administrator* and password *Administrator*. This administrator account grants full access to the system and should only be used when necessary.

A second account has been created which is intended for general use by the software. The account is setup as a member of the *Power Users* group with the username *SensorCal* and password *SensorCal*. As a member of the *Power Users* group, the *SensorCal* account has necessary write access to software folders but is restricted in terms of system access. More information concerning user accounts can be found through Windows® help.

The BIOS settings have been configured to turn the PC on after an AC power failure, and the PC is set to logon to Windows® automatically using the *SensorCal* account. This configuration is required in order for the software to successfully and automatically resume a calibration that is interrupted by a

power failure. Refer to Section 4, Power Failure Recovery, for more details on this feature.

Another important note is that no anti-virus software has been installed. The *Windows® Security Center* alert for this is turned off so that a notification does not appear each time the *Security Center* performs a scan of the system.

1.4.3   Network Configuration

The SensorCal test station computer is not configured as part of a network by default. It may, however, be joined to almost any network domain or workgroup. Doing this will enable you to use more features of the software such as e-mail notifications, allow access to shared printers, and allow the test results database to be stored on a shared network folder for facilitating backups and for using a common database to store test results from multiple SensorCal test stations. However, be aware that due to some network's security settings, it may not be possible to maximize the use of some SensorCal features such as automatic power failure recovery. Other features may have additional requirements in order to be used successfully. For example, the e-mail notification feature requires access to a SMTP (Simple Mail Transfer Protocol) server in order to function properly.

Since every network varies in its security and other configuration settings, specific information on how to join the computer to your network cannot be provided. Consult your network administrator for information and assistance on joining the SensorCal test station computer to your network domain or workgroup.

1.5   Software Installation

To successfully install the *SensorCal* calibration software, you must be logged on to Windows® as an administrator. If *SensorCal* is already installed, the repair or remove options should be used to modify the existing installation. The following instructions are intended for a new installation of the software:

1.   Insert the *SensorCal* CD-ROM into the CD-ROM drive. The Setup program should run automatically.

2.   Follow the on-screen instructions to install *SensorCal*.

3.   When prompted, enter the product serial number. The serial number is provided on a sticker typically located on the CD pouch on the inside back cover of the User's Guide. The serial number should follow the format: XXXXXX-XXXXXX-XXXXXX

4.   If the computer has been joined to your network, you may choose to install the software's "network" (or archive) database to a network share or resource. Otherwise, the "network" database will be installed to the local hard drive in the *\Archive* subfolder.

5. After all files have been installed, a program group is created in the *Start* menu with an icon for the software. The installation is complete at this point.

6. When the installation is finished, the computer may need to be restarted. When a restart is required, you must logon once using an administrator account to allow the installation to complete. Subsequent logons will not require administrative rights.

7. The *SensorCal* software icon is also added to the desktop and to the *Startup* group. This initiates the software upon logon, a necessary feature for power recovery capability.

If *SensorCal* is currently installed on the computer, the software can be repaired or removed using the *Add/Remove Programs* utility in the *Control Panel*. The following instructions are intended to repair or remove an existing *SensorCal* installation in Windows® XP:

1. Open the *Control Panel* by selecting the *Control Panel* option in the *Start* menu.

2. In the *Control Panel*, double-click the *Add/Remove Programs* icon to open the *Add/Remove Programs* dialog.

3. Locate and select *SensorCal* from the list that appears.

4. Click the *Change/Remove* button.

5. Follow the on-screen instructions to repair or remove the software.

6. When finished repairing or removing the software, close the *Add/Remove Programs* dialog.

1.5.1 GPIB Card and Software Installation

A GPIB card is installed in the computer for communication with certain components of the system. In order to use the GPIB card, *SensorCal* requires the National Instruments *Measurement and Automation Explorer* (MAX) GPIB software to be installed. This software is supplied on the CD-ROM accompanying the GPIB card. The following instructions outline the process of installing the NI MAX software and GPIB card:

1. Insert the National Instruments software CD-ROM into the CD-ROM drive. The Setup should run automatically.

2. Follow the on-screen instructions to install the NI MAX software.

3. At the end of the software installation process, you must select which type of GPIB card is to be installed in the computer. For desktop computers, the *PCI-GPIB* card should be selected. For laptop computers, the *PCMCIA-GPIB* card should be selected.

4. Shut down the computer when the software installation is complete.

5. Install the GPIB card with the computer turned off.

6. Turn the computer back on.

7. Windows® should automatically detect the new hardware and display the *Hardware Installation Wizard*. As part of the process, Windows® should be able to locate the drivers without needing the CD-ROM. When this process completes and the hardware is installed properly, follow through the National Instruments software wizard to test and verify the card.

With the GPIB card installed and verified, *SensorCal* should be able to communicate with the test equipment through the GPIB connections.

1.5.2 USB to RS-232 Adapter Installation

SensorCal requires two RS-232 (COM) ports on the computer. In the case that the computer does not have two COM ports, USB to RS-232 adapters are used to add additional COM ports. This system has been tested using the IOGear Model GUC232A USB to Serial adapter. Not all adapters may work with the system. The following instructions outline the process of installing the IOGear adapter:

1. Plug the adapter into an available USB port on the computer.

2. Windows® should automatically detect the new hardware and display the *Hardware Installation Wizard*. As part of the process, Windows® may be able to locate the drivers without needing the CD-ROM. If the CD-ROM is required, a prompt will be displayed. Insert the CD-ROM and proceed.

Once the drivers are installed successfully, *SensorCal* should be able to communicate with the test equipment through the adapter.

1.6 System Configuration

The SensorCal system is composed of various instruments, each of which serves a specific function. Figure 1 indicates how these instruments are connected to each other and to the computer system. For more details on the specific configuration and settings of each instrument, refer to Section 5, Test Equipment Configuration.

1.6.1 Ambient Conditions

The first requirement regarding system configuration is the location of the system. In order to achieve optimum results, this system needs to be located in a controlled environment. We recommend the following ambient conditions be observed:

Temperature: 23°C ±2°C

Humidity: 15%RH to 60%RH

Keithley 7001

Use 6' PS/2 cables
(Belkin F2N035-06)

To DewK Ch. 1

To 7011-S Output

To 7011-S
Ch. 1-10

To UUTs
(in Manifold)   PS/2 connections

IEEE

Thunder 2500 Chamber

To DewK Ch. 2

RS-232 COM2

To Check Std
(in Manifold)

IEEE

Temp. Reference
(in Manifold)

**5610
Thermistor**

1504 'Tweener'

RS-232 COM1
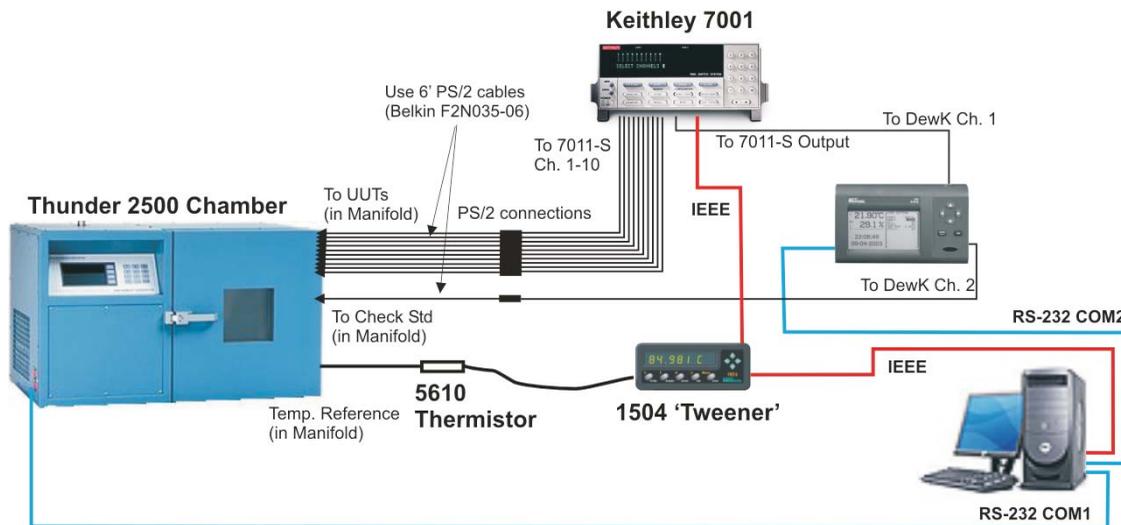
Figure 1   *Sensor Cal Instrument Connections Diagram*

1.6.2   Chamber Installation

The chamber is used as the source of the temperature and humidity for the calibrations.

Connect the power cord and air supply to the chamber as directed by the Operation and Maintenance Manual provided with the chamber.

Connect the *Console* port on the left side of the chamber to one of the COM ports on the computer using the serial cable provided with the chamber. If needed, use a "straight through" type 9-pin extension cable.

Make sure you leave adequate space around all sides of the chamber for proper air flow.

1.6.3   Manifold Installation

The manifold and sensor holding fixture are used to provide a stable, consistent, uniform environment within the chamber for the sensors and temperature reference probes. The manifold is installed in the chamber as shown in Figure 2 by threading the manifold's nipple into the chamber's inlet port. Orient the manifold in a vertical position so that the copper tubes are on the top and bottom sides of the manifold.

Remove the foam plug from one of the ports on the right side of the chamber. Pull the PS/2 cables from the manifold's sensor holding fixture through the port from the inside out. Also pull the temperature reference probe wire through the port, with the temperature probe on the inside of the chamber. Leave enough slack in the PS/2 cables and reference probe wire inside the chamber to be able
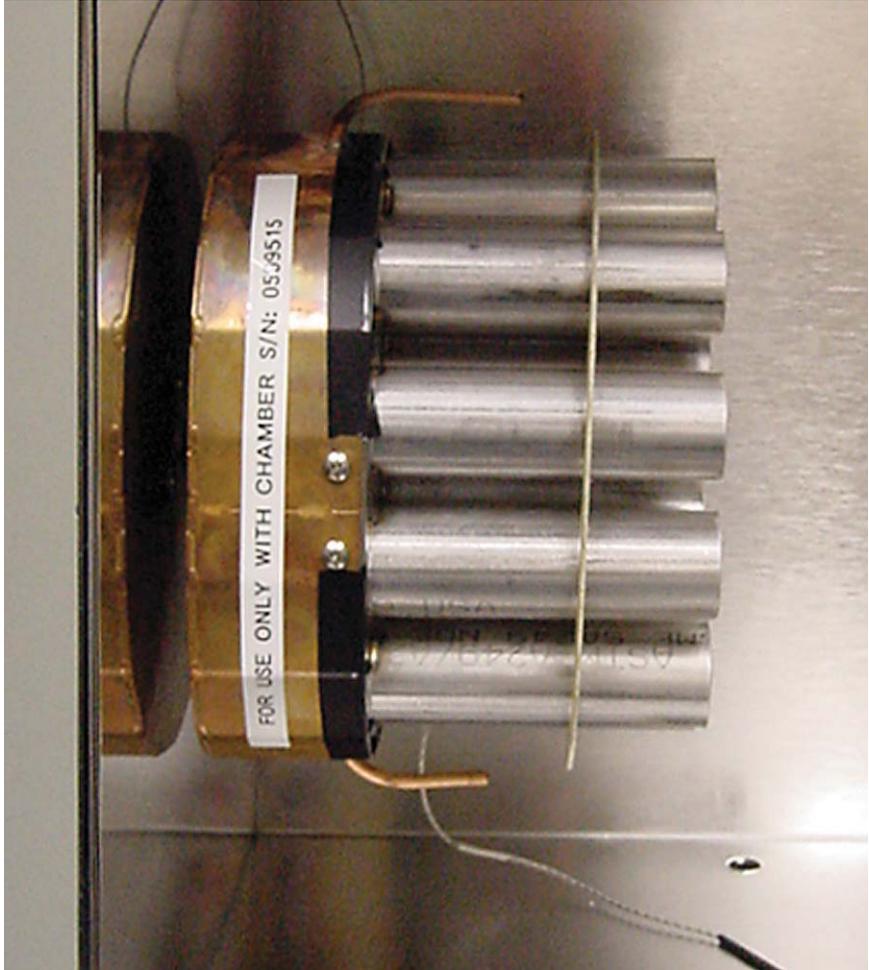
Figure 2 *Manifold installation*

to maneuver the sensor holding fixture as needed. Replace the foam plug in the port.

The chamber's temperature sensor is located in the upper back left corner inside the chamber. Gently pull the sensor down into the chamber. Pull the sensor down enough to be able to insert the sensor into the sensor holding fixture. In-

sert the temperature reference probe and the chamber's temperature sensor into the holes in the sensor holding fixture as indicated in Figure 3.
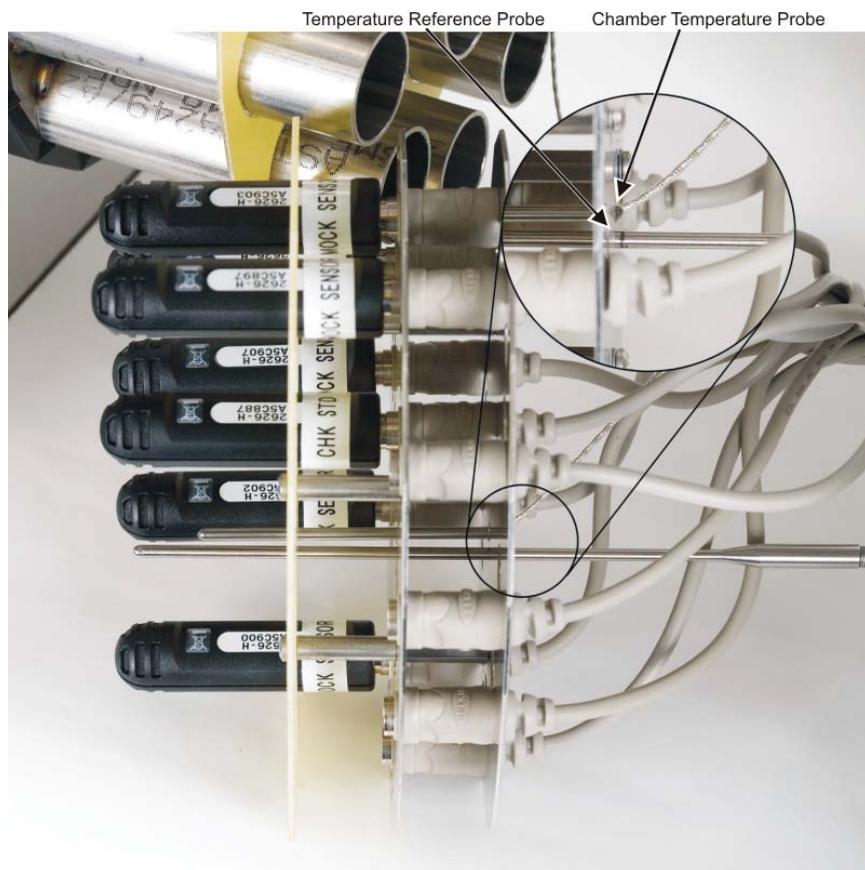
Figure 3 *Temperature probe insertion positions and marking*

The chamber's temperature sensor should be inserted completely so that the junction of the wire and sheath is flush with the outer plate of the sensor holding fixture (see insert in Figure 3). The temperature reference probe should be inserted so that the tip of the probe aligns roughly with the tip of the check standard sensor when inserted into the sensor holding fixture as indicated in Figure 3. Use scotch tape or a permanent marker to mark the insertion depth of the temperature reference probe as indicated in inset in Figure 3. This will facilitate ensuring the probe is inserted to the proper depth prior to starting each calibration.

1.6.4 Switch/Multiplexer Installation

The multiplexer, or switch, is used to connect any one of the sensors being calibrated (UUTs) to the readout device, one at a time, so that measurements can be taken on that sensor. The multiplexer uses only one card. The card is wired with PS/2 cables on 10 input channels and one output channel.

Connect the power cord to the multiplexer as directed by the owner's manual provided with the multiplexer.

Connect multiplexer's IEEE port to the IEEE card in the computer using the shielded IEEE cable provided.

Connect the 10 input PS/2 cables to the PS/2 cables from the manifold by matching up the labels on each cable. If a cable is not labeled, take the necessary precautions to make sure the correct connections are made. This may be done once the rest of the test equipment is connected by connecting a sensor to the appropriate position of the sensor holding fixture in the manifold, setting the multiplexer to activate the proper channel, and making sure the sensor readings appear on the readout device.

⚠️ *CAUTION: It is very important to connect each cable properly! Mixing up the connections (i.e. connecting the Sensor 1 cable from the manifold to the Sensor 2 cable from the multiplexer, etc.) can invalidate the calibration!*

1.6.5 Thermo-hygrometer Readout/Logger Installation

The thermo-hygrometer readout is used to take readings from the 10 UUT sensors and the check standard sensor.

Connect the AC adapter to the readout as directed by the owner's manual provided with the readout.

Connect readout's RS-232 port to one of the COM ports on the computer using the serial cable provided with the readout.

Connect the PS/2 cable from the output channel of the switch to the readout device channel 1 connector on the top right side of the readout.

Connect the PS/2 cable for the check standard sensor from the sensor holding fixture of the manifold to the readout device channel 2 connector on the lower right side of the readout. You may use a PS/2 extension cable (provided) if necessary.

1.6.6 Temperature Reference Readout Installation

The temperature reference readout and probe are used to provide an accurate temperature reference for the calibration of the sensors.

Connect the power cord to the readout as directed by the owner's manual provided with the readout.

Connect readout's IEEE port to the IEEE card in the computer using the shielded IEEE cable provided.

Connect the temperature reference probe already installed in the manifold to the readout. Make sure the probe's calibration coefficients are properly programmed into the readout before starting a calibration.

2   Operation

This section is intended to assist in getting the *SensorCal* software up and running. The computer is configured to launch *SensorCal* automatically on startup. The software may also be launched by double-clicking the icon on the desktop or by going through the *Programs* option in the *Start* menu. Some setup is required to get the system ready to run calibrations. Once properly configured, *SensorCal* can run calibrations and provide access to the resulting data.

2.1   Before You Start

Before getting started using *SensorCal* there are setup and configuration steps that should be taken care of. The following provides an explanation on what options can be configured for the software as well as the specific setup for system test equipment.

2.1.1   SensorCal Options

The *SensorCal Options* dialog allows various software settings to be configured. This dialog is accessed by selecting the *Options…* option in the *Tools* menu.
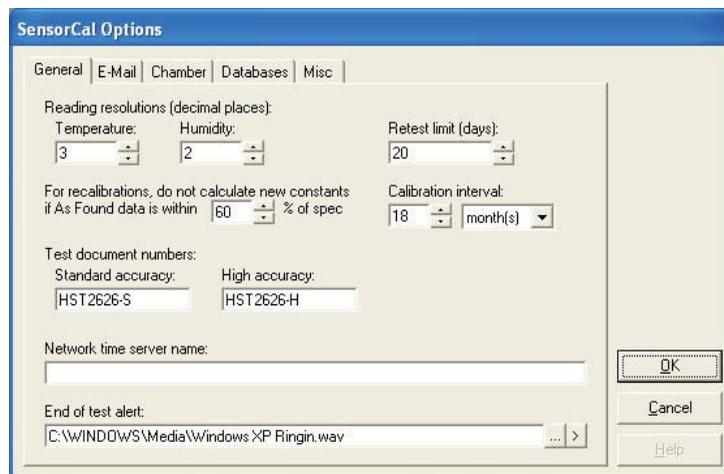
Figure 4 *SensorCal Options dialog*

The settings are divided amongst five tabs: *General*, *E-Mail*, *Chamber*, *Databases*, and *Misc*. The following sections describe the settings on each of these tabs.

2.1.1.1　General tab

The *General* tab displays options for the general use of *SensorCal*.
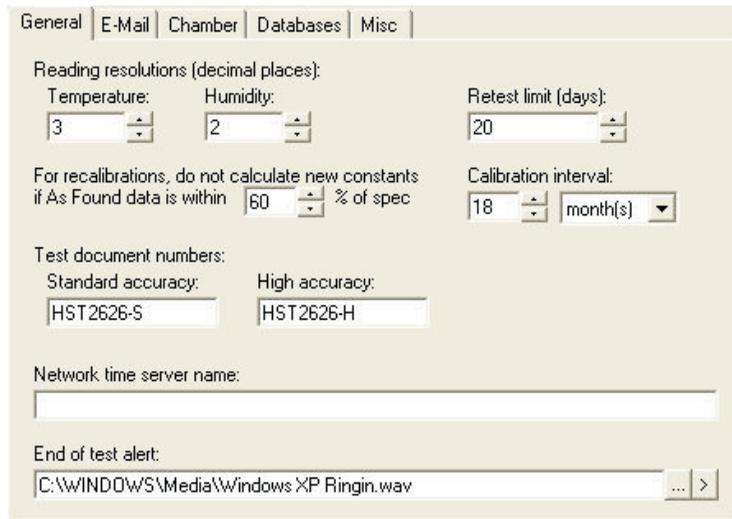
Figure 5　*SensorCal Options dialog - General tab*

The *Reading resolutions* settings determine the resolution for temperature and humidity readings taken during a calibration. The selections indicate the number of decimal places stored for each type of reading. The recommended settings are 3 digits for temperature and 2 digits for humidity.

The *Retest limit* setting is the interval used when checking for previous calibrations of the sensor. If another calibration record is found within the retest limit interval (in days), the software prompts the technician to select a reason for retesting the sensor before starting the calibration. For more details on retest reasons, refer to Section 2.1.1.5, Misc tab.

The *For recalibrations, do not calculate new constants if As Found data is within … % of spec* setting is a tolerance for determining if new calibration constants should be calculated. If the As Found data taken is within the specified percentage of the calibration specification, the software uses the As Found data for the As Left results and does not attempt to align the sensor by calculating new constants.

The *Calibration interval* setting determines the interval to use when calculating a sensor's due date. The sensor's calibration date is always set to the current date, according to the computer's clock, when new calibration constants are calculated and programmed into the sensor. The due date is calculated from the calibration date using this setting.

The *Test document numbers* store the reference name or number of the documents outlining the formal calibration procedure. These numbers are recorded with each calibration record and are printed on the test report and Report of Calibration.

The *Network time server name* setting specifies the name of a computer on the network to get time from. The software uses the local computer time for time stamping events, such as the beginning and ending of a calibration. If a computer name is specified, the software will attempt to synchronize the local computer's clock with the specified computer before beginning a calibration. If the computer is not configured as part of a network, leave this box empty.

The *End of test alert* setting specifies an audio file to be played as an audible alert upon completing a calibration. Click the "…" button to browse for a WAV file to play. To test the selected file, click the ">" button.

2.1.1.2   E-Mail tab

The *E-Mail* tab provides the user with a way to configure the communication of test events via e-mail. This tab displays the contents of the *EMailEvents.ini* file stored in the application's folder. E-mail options can only be used if the computer is configured as part of a network and has full access to a SMTP mail server. Otherwise, all e-mail settings are ignored.
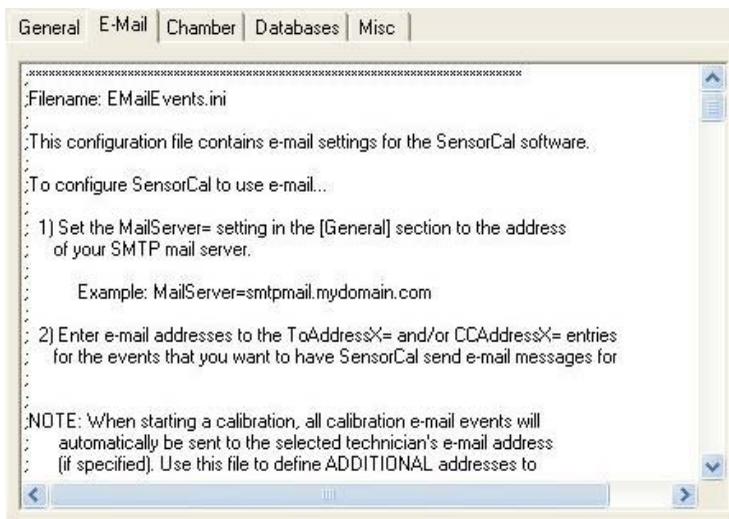
Figure 6 *SensorCal Options dialog - E-mail tab*

The *EMailEvents.ini* file follows the same conventions as a standard Windows® INI file. Instructions are embedded in the file.

The *[General]* section of the file specifies the three common components for all e-mails. The *MailServer=* entry refers to the SMTP server used in sending

messages. The *FromAddress=* entry is the address specified as the sender for all e-mails. The *LogFile=* entry is the path and filename for the log file containing details of communication with the SMTP server.

The remainder of the file is broken into sections. Each section is named for the corresponding event in the software that triggers an e-mail message to be sent. The section name is referenced by the software to identify the particular entry and should never be changed. Configurable options in each section include the *Subject=* entry, which is used as the e-mail subject line, and the *ToAddressN=* and *CCAddressN=* entries, used to specify recipients of the message.

For calibration related events such as *[TestStarted]*, *[TestAborted]*, etc., the technician whose name was selected when the calibration started is automatically included as a recipient for e-mail messages if the technician's e-mail address is known. Refer to Section 2.1.1.5, Misc tab, for more details on configuring technician e-mail addresses. Use the *ToAddressN=* and *CCAddressN=* entries to specify additional recipients, such as managers, supervisors, etc., for the e-mail messages.

2.1.1.3   Chamber tab

The *Chamber* tab provides settings that affect how the software interacts with the temperature/humidity chamber during a calibration. While this dialog allows the user access to change these settings, the default values have been determined to be the optimal settings for the system. It is recommended that these settings not be changed as they may significantly impact system performance.
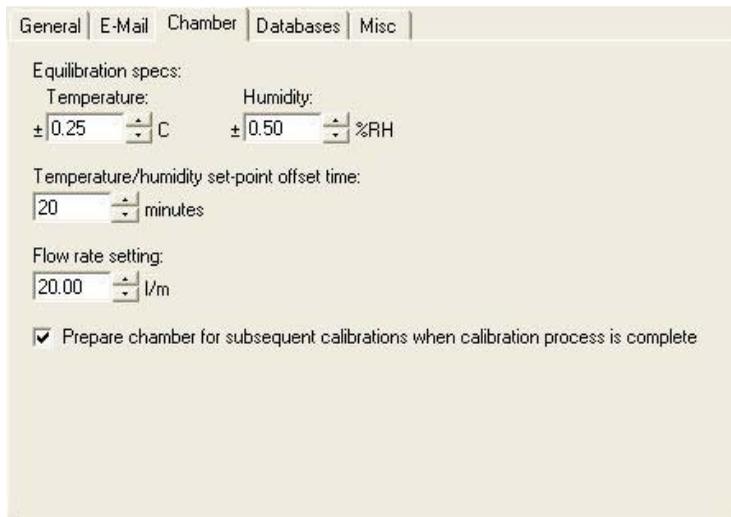

Figure 7 *SensorCal Options dialog - Chamber tab*

The *Equilibration specs* settings set limits for determining when the chamber has stabilized at the temperature and humidity set-points. Calibration will not proceed until the temperature and humidity readings are stable within the limits set by the equilibration specs. The recommended default values are ±0.25°C for temperature and ±0.50%RH for humidity. However, depending on the chamber's calibration, slightly greater values may be required. The temperature spec is actually used with the readings from the temperature reference readout and probe and the humidity specs are used with the chamber's %RH@PcTc reading.

The *Temperature/humidity set-point offset time* setting is used to stagger the setting of the chamber's temperature and humidity set-points during a calibration. Rather than set both temperature and humidity set-points simultaneously, the software sends the command to set the temperature, waits for the specified time interval (in minutes), and then sends the command to set the humidity. This helps prevent the chamber from requiring more air pressure than is available to the system in certain situations. The recommended setting is 20 minutes.

The *Flow rate setting* option adjusts the chamber flow rate (in liters/minute), the rate at which the conditioned air is ported into the chamber. The recommended setting is 20 l/m.

The *Prepare chamber for subsequent calibrations when calibration process is complete* option determines how the chamber is handled when a calibration finishes. If checked, the chamber will remain in run mode and the temperature set-point will be set to 15°C. If unchecked, the chamber will be shut down.

2.1.1.4   Databases tab

The *Databases* tab provides access to database file locations. The database file

locations can be viewed and changed for each of the three system databases: *Test settings*, *Local test results*, and *Network test results*.
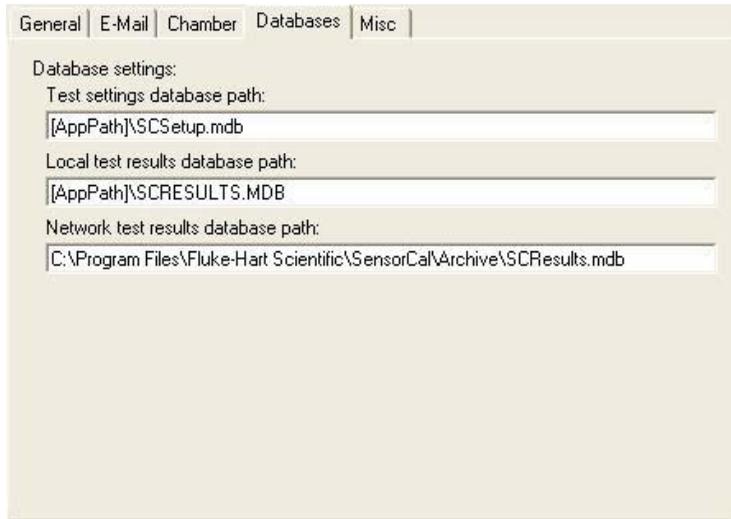
Figure 8 *SensorCal Options dialog - Databases tab*

The *Test settings database path* indicates the path and name of the database that contains test settings information and temperature profile offset data. By default, this database is located in the application folder. The location of this database can be changed by moving the specified database file to another location and indicating the path.

The *Local test results database path* indicates the path and name of the temporary database to which test results are written during a calibration. By default, this database is also located in the application folder. The location of this database can be changed by moving the specified database file to another location and indicating the path. It is strongly recommended that this database remain on the local computer.

The *Network test results database path* indicates the path and name of the permanent database to which test results are moved once a calibration is complete. By default, this database is located in the *\Archive* subfolder of the application folder, unless otherwise specified when the software was installed. The location of this database can be changed by moving the specified database file to another location and indicating the path.

The network database is also referred to as the archive database. All reporting and exporting features of the software are performed against the network database.

If the SensorCal test station computer is joined to a network, this database can be relocated to a network share or resource. This can facilitate the backup of

SensorCal test results by existing network backup procedures. Also, if multiple SensorCal test stations are implemented, this database can be shared by all test stations as a central storage location for all test results.

All database paths support local paths (i.e. C:\foldername\databasename.mdb) and universal naming convention (UNC) paths (i.e. \\servername\foldername\databasename.mdb). All database paths also support using the *[AppPath]* mnemonic (i.e. [AppPath]\foldername\databasename.mdb) to indicate the path where the SensorCal software is installed.

If the computer is configured as part of a network, you may wish to move the network test results database to a shared folder on the network by moving the database file from the *\Archive* subfolder and changing the path indicated as the *Network test results database path* setting to reflect the new location.

2.1.1.5 Misc tab

The *Misc* tab provides options for configuring technician and retest reasons information.

Figure 9 *SensorCal Options dialog - Misc tab*

Both sections of the *Misc* tab have the same options and behave similarly. The *Technicians* list displays the names and e-mail addresses (if applicable) of the technicians who may perform calibrations. The *Retest reasons* list displays a list of reasons that the user shall be presented with when a sensor is being retested with the limit specified on the *General* tab.

There are three operations that can be performed in either section. The *New* button opens a dialog to create a new entry. The *Edit* button opens a dialog al-

lowing the entry selected from the list to be modified. The *Remove* button deletes the selected entry completely.

When adding a new technician name, the e-mail address is optional. If included, and the e-mail features are enabled, the technician will receive calibration process related e-mail messages while a calibration is being performed.

2.1.2   Test Equipment

The *Test Equipment* dialog configures communication with the various instruments used in the system. To access this dialog, select the *Test Equipment…* option in the *Tools* menu.
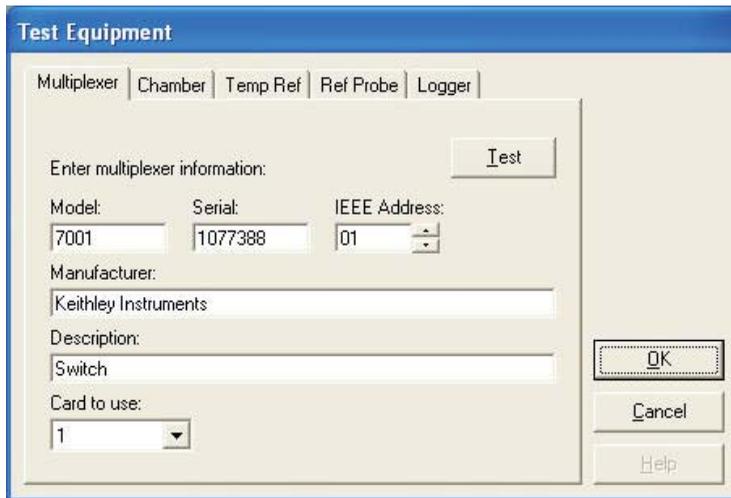
Figure 10   *Test Equipment dialog*

The *Test Equipment* dialog has a tab with the pertinent settings for each instrument: *Multiplexer*, *Chamber*, *Temp Ref*, *Ref Probe*, and *Logger*. All instruments have *Model*, *Serial*, *Manufacturer*, and *Description* fields. These settings should be filled in with the correct details for each instrument. The contents of the *Model* field on all tabs is locked and cannot be modified. SensorCal only supports using the models indicated.

Communication settings and other options particular to each instrument are described in the following sections for each tab.

2.1.2.1   Multiplexer tab

The *Multiplexer* tab indicates the multiplexer to be used to connect multiple

UUT sensors to a single channel of the readout. The multiplexer may also be referred to as the switch.

Figure 11 *Test Equipment dialog - Multiplexer tab*

Additional settings on this tab configure and test the IEEE communications with the multiplexer. The *IEEE Address* setting specifies the address that should be used to communicate with the multiplexer. Make sure this setting matches the IEEE address setting in the multiplexer. Click the *Test* button to verify communications with the multiplexer.

The *Card to use* setting refers to the slot in the multiplexer that the card is installed in.

2.1.2.2   **Chamber tab**

The *Chamber* tab indicates the humidity chamber to be used.

Figure 12   *Test Equipment dialog - Chamber tab*

Additional settings on this tab configure and test the serial communications
(RS-232) with the chamber. The *COM port* and *Baud rate* settings must match
the chamber's *console* communication settings. Click the *Test* button to verify
communications with the chamber.

The *Cal date* and *Recal date* settings indicate the calibration information for
the chamber. SensorCal prevents calibrations from being performed using ex-
pired test equipment by checking these dates when starting a calibration.
SensorCal will start to display warning messages and sending e-mail messages
(if enabled) when starting a calibration within 7 days of any test equipment cal-
ibration expiring.

If the chamber has known errors at the humidity test set-points (20%, 45%, and
70%RH), you may enter offset values to correct for these errors by clicking the
Offsets... button. Refer to Section 2.1.3.1, Chamber Humidity Offsets, for more
information on setting up humidity offset values.

2.1.2.3 Temp Ref tab

The *Temp Ref* tab indicates the temperature reference readout to be used.

Figure 13 *Test Equipment dialog – Temp Ref tab*

Additional settings on this tab configure and test the IEEE communications with the readout. The *IEEE Address* setting specifies the address that should be used to communicate with the readout. Make sure this setting matches the IEEE address setting in the readout. Click the *Test* button to verify communications with the readout.

The *Cal date* and *Recal date* settings indicate the calibration information for the readout. SensorCal prevents calibrations from being performed using expired test equipment by checking these dates when starting a calibration. SensorCal will start to display warning messages and sending e-mail messages (if enabled) when starting a calibration within 7 days of any test equipment calibration expiring.

2.1.2.4   Ref Probe tab

The *Ref Probe* tab indicates the temperature reference probe to be used.

Figure 14   *Test Equipment dialog – Ref Probe tab*

The *Cal date* and *Recal date* settings indicate the calibration information for the probe. SensorCal prevents calibrations from being performed using expired test equipment by checking these dates when starting a calibration. SensorCal will start to display warning messages and sending e-mail messages (if enabled) when starting a calibration within 7 days of any test equipment calibration expiring.

2.1.2.5   **Logger tab**

The *Logger* tab indicates the thermohygrometer logger readout to be used.

Figure 15 *Test Equipment dialog - Logger tab*

Additional settings on this tab configure and test the serial communications (RS-232) with the logger. The *COM port* and *Baud rate* settings must match the logger's communication settings. Click the *Test* button to verify communications with the logger.

The *UUT Channel* setting refers to the channel of the logger that the UUT sensors are connected to through the multiplexer card. Select the appropriate channel.

The *Chk Std Chn* setting refers to the channel of the logger that the check standard sensor is connected to. Select the appropriate channel.

2.1.3   Chamber Profile Data and Offsets

SensorCal includes some features that can be used to increase the accuracy of calibrations. These features can be used to apply offsets to temperature and humidity measurements to correct for known errors in measurements from the reference instruments. The following sections describe these features in more detail.

2.1.3.1   **Chamber Humidity Offsets**

The *Chamber Humidity Offsets* dialog allows the user to define offset values at

specific humidity set-points to correct for known errors. To access this dialog, click the *Offsets…* button on the *Chamber* tab on the *Test Equipment* dialog.

Figure 16 *Chamber Humidity Offsets dialog*

⚠️ **CAUTION:** *Do not attempt to use this feature if you are unsure or unfamiliar with its purpose. Improper use of this feature can invalidate sensor calibrations! Humidity calibration typically requires the use of a chilled mirror and/or other test equipment. This process is beyond the scope of the documentation of this system.*

The *Humidity Offsets* tab displays a grid with the current humidity set-points and offset values to apply. If the list is empty, no offsets will be applied to any humidity readings.

To add an offset value, right-click on the grid and select *Add New Offset…* from the popup menu. The *Add Humidity Offset* dialog is displayed.
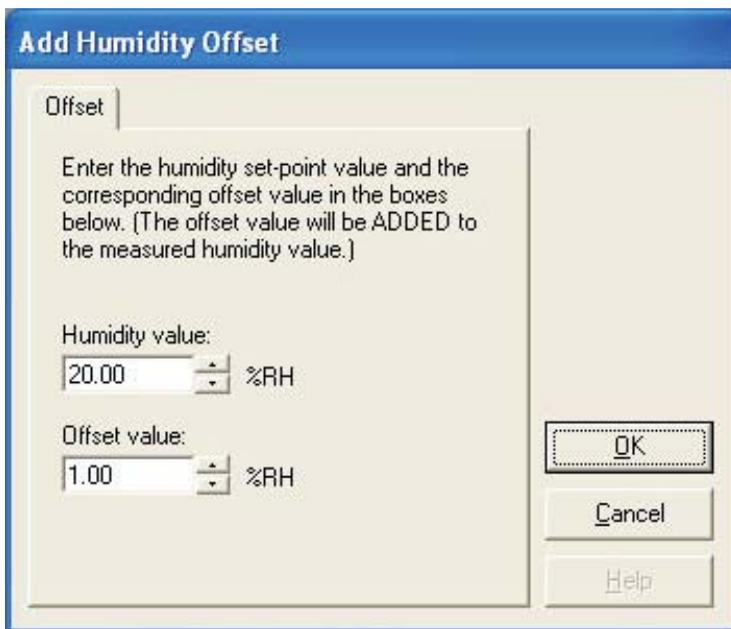
Figure 17   *Add Humidity Offset dialog*

Enter the humidity set-point (nominal value) and offset value to add to readings taken from the chamber at this set-point and click *OK* to save the settings. SensorCal will only apply offset values associated with the humidity set-points used to perform calibrations (20%, 45%, and 70%RH). Any other offsets are ignored.

To modify an existing offset value, highlight the appropriate row in the grid,

then right-click on the grid and select *Modify Offset at xx.xx%RH* from the popup menu. The *Modify Humidity Offset* dialog is displayed.
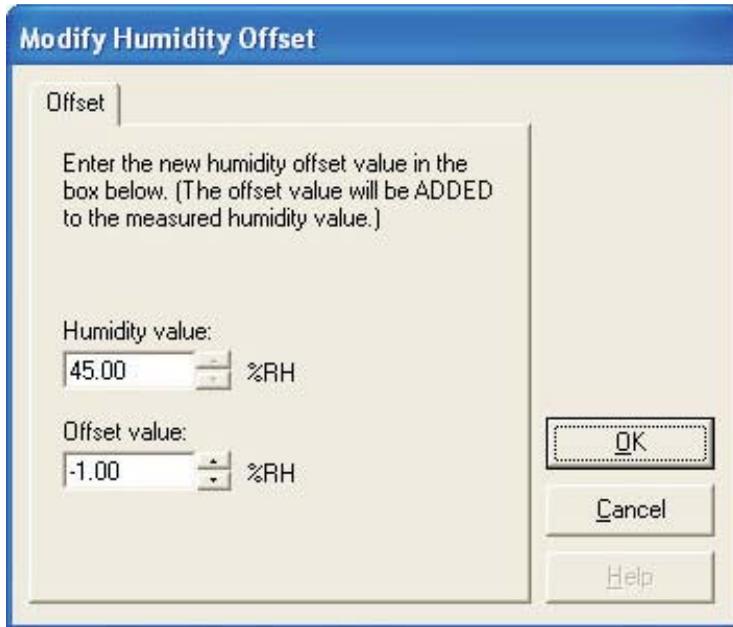
Figure 18   *Modify Humidity Offset dialog*

Change the humidity set-point and/or offset value and click *OK* to save the settings.

To remove an existing offset value, highlight the appropriate row in the grid, then right-click on grid and select *Remove Offset at xx.xx%RH* from the popup menu.

Removing all items from the grid will still leave one row in the grid with a humidity set-point of 0.00 and an offset value of 0.00. This is normal.

For information on configuring temperature offset values, refer to Section 2.1.3.2 , Chamber Temperature Profile Data.

2.1.3.2   Chamber Temperature Profile Data

The *Chamber Temperature Profile Data* dialog provides a means to enter temperature offset values to apply to the temperature reference readings for each sensor position in the manifold for each temperature set-point. To access this

dialog, select the *Manual Profile Data Entry...* option in the *Chamber Temperature Profile* submenu in the *Tools* menu.

Chamber Temperature Profile Data

Profile Data

Enter the chamber temperature profile data calculated using the spreadsheet provided. Note that these offsets are chamber specific and apply ONLY to the chamber indicated below. Changing any value will set the update date to today.

Chamber model: 2500ST

Chamber serial: 0509515

Updated: 1/12/2006

Standard accuracy sensor calibrations:

Manifold -->					Position						
Set-point (C)	1	2	3	4	5	6	7	8	9	10	Chk Std
15	0.000	0.002	0.001	0.002	-0.005	-0.003	0.000	0.015	0.003	0.052	0.001
25	-0.001	-0.002	-0.001	0.000	0.000	-0.004	0.003	-0.005	0.002	0.003	0.002
35	0.000	-0.002	-0.005	-0.021	-0.006	0.008	0.001	0.000	0.005	-0.006	0.003

All values are in Celsius

High accuracy sensor calibrations:

Manifold -->					Position						
Set-point (C)	1	2	3	4	5	6	7	8	9	10	Chk Std
16	-0.001	0.000	-0.003	0.004	0.008	0.002	0.000	0.001	0.005	-0.010	0.006
20	0.000	0.001	0.031	0.027	0.006	0.004	-0.005	-0.008	0.051	0.003	0.004
24	-0.002	-0.005	-0.004	0.000	-0.020	-0.003	0.001	0.000	0.006	0.021	0.000

OK   Cancel   Help

These values are ADDED to the readings taken from the temperature reference readout and probe.

Figure 19 *Chamber Temperature Profile Data dialog*
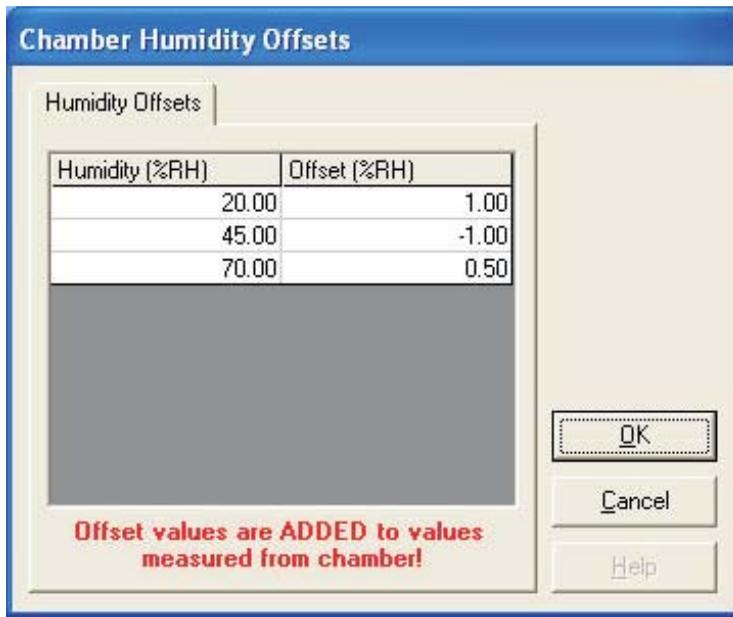
⚠️ *CAUTION: Do not attempt to use this feature if you are unsure or unfamiliar with its purpose. Improper use of this feature can invalidate sensor calibrations!*

The chamber temperature profile data is basically a map of offsets to correct for known temperature errors for each sensor position in the manifold at each temperature set-point for each type of calibration. SensorCal does not require offset values to be entered, however performing a temperature profile on the chamber/manifold can improve the temperature calibration results. Profile offset values can be manually calculated by following the instructions in Section 6, Chamber Temperature Profile Procedure.

Indicated offset values are added to the readings taken from the temperature reference readout/probe when data is being taken for each sensor.

⚠️ *CAUTION: Profile offset values are specific to a chamber/manifold combination. You should not assume that using one chamber with a manifold will have the same basic profile as using a different chamber with the same manifold. For this reason, the manifold is labeled for use only with a specific chamber.*

The currently configured chamber is indicated in the *Chamber model* and *Chamber serial* boxes on this dialog. The offsets entered on this dialog will apply **only** to the chamber indicated. If the chamber information is incorrect, change the chamber settings using the *Test Equipment* dialog before proceeding. Refer to Section 2.1.2.2, Chamber tab, for more information.

The *Updated* date near the top of the dialog indicates the date the offset values were last modified. Changing any value on this dialog causes the date to be set to today's date.

Once the manual chamber temperature profile procedure is complete, enter the offset values into the *Standard accuracy sensor calibrations* and *High accuracy sensor calibrations* grid cells.

To reset all offset values, enter *0.000* in all grid cells.

For information on configuring humidity offset values, refer to Section 2.1.3.1, Chamber Humidity Offsets.

2.2 Performing Calibrations

The primary purpose of SensorCal is to calibrate Hart Model 2626-x temperature/humidity sensors. The following sections detail the calibration process.

2.2.1 Sensor Settings

To start a new calibration, select either the *Standard Accuracy…* or *High Accuracy…* option in the *New Test* submenu in the *File* menu. The *Sensor Settings*

dialog is displayed with a message to load the sensors into the manifold before proceeding.
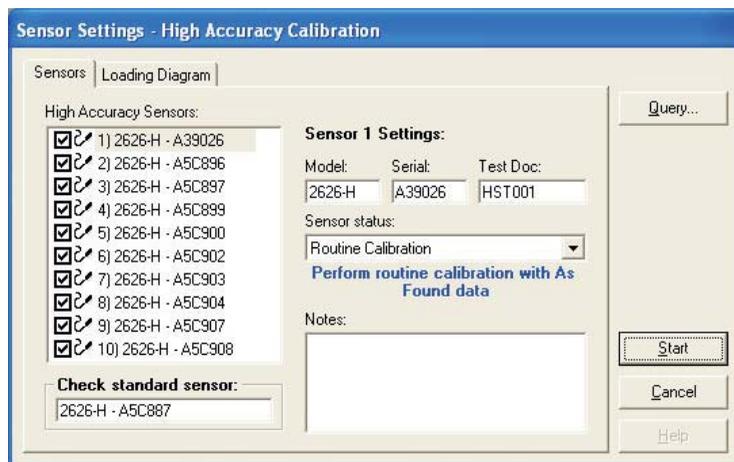
Figure 20 *Sensor Settings dialog*

Make sure the manifold is fully loaded with the sensors to calibrate, including the appropriate check standard sensor. Sensors that are to be calibrated (UUTs) are loaded into the manifold positions labeled "1" to "10". The check standard sensor must be loaded into the position labeled "CS". For simplicity, the recommended loading order begins with position "1" and continues sequentially (see Loading Diagram tab). All sensors loaded in the manifold must be of the same type, including the check standard sensor, and correspond with the test type being performed.

⚠️ *CAUTION: The manifold MUST be fully loaded to perform a calibration! When calibrating less than 10 sensors, use the "mock" sensors provided with the system as fillers. These sensors are used as placeholders to provide consistency in the manifold and do not need to have data gathered from them. All "mock" sensors must also be of the same type as the sensors being calibrated.*

Once all sensors are loaded into the manifold, insert the sensors into the manifold tubes by sliding the sensor holding fixture onto the manifold using the tube guides and secure in place. Make sure the chamber temperature sensor and the temperature reference probe are properly inserted into the manifold. Place the foam insert in the chamber door opening and close the chamber door.

Click *OK* on the message box to allow SensorCal to automatically read in all sensor models and serial numbers. The calibration process cannot begin until the sensor information has been successfully queried. This process can also be initiated by clicking the *Query…* button on the dialog. If the manifold was not

fully loaded, or if incorrect sensor types are detected, a warning message is displayed and this process must be repeated.

After the sensor information is read in, the sensors are listed in the *Sensors* list and the check standard sensor information is listed in the *Check standard sensor* box. The checkbox next to each sensor in the list determines whether or not data will be gathered from the sensor. This checkbox should be checked for all sensors to be calibrated. "Mock" sensors should be disabled by unchecking the appropriate checkbox(es). Data is always taken from the check standard sensor.

Selecting a sensor in the *Sensors* list displays the settings for the selected sensor. The *Model*, *Serial*, and *Test Doc* fields are not editable and are filled in as the sensor is queried. The test document number is determined by the setting on the *General* tab of the *Options* dialog. Refer to Section 2.1.1.1, General tab, for more details.

The *Sensor status* must be selected for each sensor before the calibration will begin. The sensor status determines whether or not As Found and/or As Left data is taken, and whether or not the software should calculate new calibration constants for the sensor. This setting also affects the data reported on the Report of Calibration. Options for the sensor status are as follows:

- **Routine Calibration** performs the entire calibration process. As Found data is reported on the Report of Calibration.

- **Recalibration** is generally performed only upon customer request. As Found data is *not* reported on the Report of Calibration.

- **Inoperative** applies to sensors that are non-operational upon receipt. Due to necessary repairs, As Found data could not be taken with the original parameters. As Found data is *not* reported on the Report of Calibration.

- **Repair** indicates that minor repairs have been made before calibration. As Found data is reported on the Report of Calibration.

- **As Found Only** takes only As Found data from the sensor without performing any sort of alignment or taking As Left data. The dates in the sensor are not changed. As Left data is *not* reported on the Report of Calibration. The *Calibration Date* on the Report of Calibration is set to the date the test was performed and the *Calibration Due* date is set to *Not Defined*.

The *Loading Diagram* tab has a graphic representation of the chamber manifold. The diagram is numbered to indicate the sensor positions as used by the software. Use this as a reference when verifying sensor information.

Click the *Start* button to begin the calibration process.

2.2.2   Start Calibration

After setting up the sensors, there are a few additional items of information ap-

plicable to the entire test that must be gathered prior to starting a calibration. The *Test Information* dialog is displayed to gather this information.

Figure 21 *Test Information dialog*

Each calibration is assigned a unique test number. The *Test number* field displays the assigned test number for the calibration. This number is automatically created and cannot be changed.

Select the name of the technician performing this test using the *Technician* drop-down list. When a technician is selected, the technician's e-mail address is displayed (if applicable). For information on setting up or modifying technician names and e-mail addresses, refer to Section 2.1.1.5, Misc tab.

Enter the current ambient conditions for the room where the system is located. It is recommended that the ambient temperature be between 21ºC and 25ºC and the ambient humidity be between 15%RH and 60%RH to perform a calibration. SensorCal will display warning messages if these recommended settings are not met, but you may choose to proceed with performing the calibration anyway if desired.

Click *OK* to start the calibration.

2.2.2.1   Calibration Process

As the calibration starts the system begins communicating with the test equipment and initializes the system.

If SensorCal determines that a sensor has been calibrated within the number of days specified as the retest limit on the *Options* dialog, the *Retest Reason* dialog is displayed prompting for a retest reason to be supplied. Select a reason from the *Reason for retesting this sensor* drop-down list. Optionally, you may enter remarks regarding the reason for retesting this sensor in the *Remarks* box. This information prints on the test report. Refer to Section 2.1.1.1, General tab, for details on setting the retest limit and Section 2.1.1.5, Misc tab, for more information on configuring retest reasons.
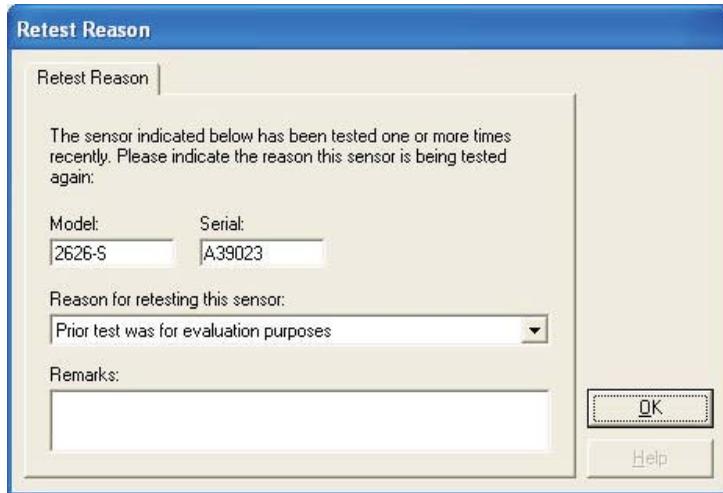
Figure 22   *Retest Reason dialog*

If enabled, e-mail messages are generated for various events that occur during a calibration. The selected technician will *always* receive all calibration related e-mail messages. E-mail messages will also be sent to all addresses defined in the e-mail settings file for each calibration event. Refer to Section 2.1.1.2, E-Mail tab, for more information on configuring e-mail settings.

Two windows are displayed: *Graphs* and *Test*. These windows provide the latest information as the test progresses.
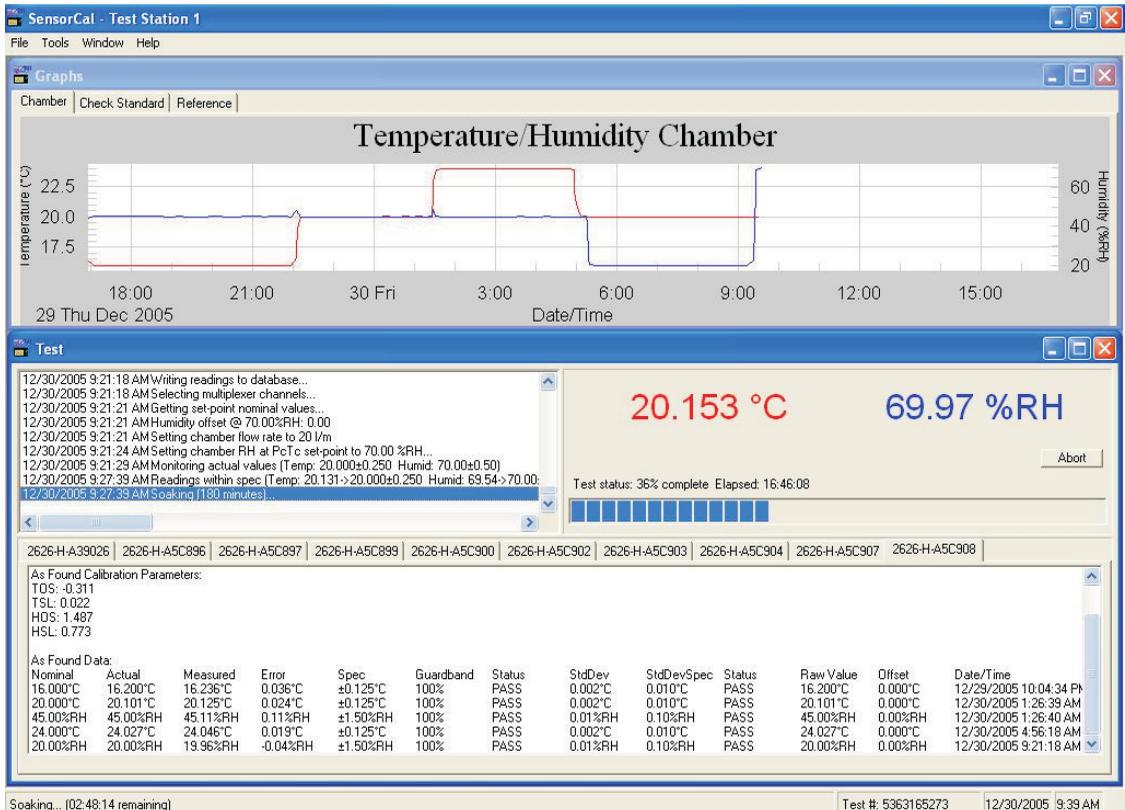
Figure 23 *Performing a calibration*

The *Graphs* window has three tabs: *Chamber*, *Check Standard*, and *Reference*. Each tab shows a graph based on the readings from the specified instrument. As the test progresses the graph is updated to show the most recent readings for both temperature and humidity.

The *Test* window has three sections. Information regarding the current status and progress of the test are displayed in the upper left section. The current reference readings, elapsed time, and percent complete progress indicator are displayed in the upper right section. This section also displays two progress bars immediately below the current readings when the software is waiting for the reference readings to equilibrate. These progress indicators are hidden otherwise. For more information regarding the equilibration specs, refer to Section 2.1.1.3, Chamber tab. The bottom half of the *Test* window has the updated calibration results. Each sensor being calibrated has a tab containing the informa-

tion that has been gathered from it. At any given time this portion of the window can be accessed to view test data for each sensor.

SensorCal proceeds to communicate with the chamber, multiplexer, logger, and temperature reference equipment to perform the calibration. Readings are taken from the chamber and temperature reference every 5 seconds and displayed in the *Test* window.

The temperature and humidity set-points, specs, soak times, and other settings are all pre-defined and cannot be changed. Refer to Table 2 and and Table 3 for details of test settings.

Table 2 *Standard Accuracy Calibration Settings*

Test Order		Set-points		Specs		Soak (mins)	Samples
As Found	As Left	Temp.	Humid.	Temp.	Humid.		
1	3	15°C	45%RH	±0.250	-	90	20
2	4	25°C	45%RH	±0.250	±2.00	60	20
3	5	35°C	45%RH	±0.250	-	60	20
4	2	25°C	20%RH	-	±2.00	90	20
5	1	25°C	70%RH	-	±2.00	120	20

Table 3 *High Accuracy Calibration Settings*

Test Order		Set-points		Specs		Soak (mins)	Samples
As Found	As Left	Temp.	Humid.	Temp.	Humid.		
1	3	16°C	45%RH	±0.125	-	150	20
2	4	20°C	45%RH	±0.125	±1.50	120	20
3	5	24°C	45%RH	±0.125	-	120	20
4	2	20°C	20%RH	-	±1.50	150	20
5	1	20°C	70%RH	-	±1.50	180	20

In addition to the settings indicated in the above tables, SensorCal uses a guardband of 60% on all As Left data. This means that all As Left data must be within 60% of the indicated specs in order to receive a "pass" status on the test report. Test results that exceed the guardband, but still fall within the indicated specs, receive a "marginal" status. Test results that exceed the indicated specs receive a "fail" status.

The *Sensor status* setting for each sensor, which was selected on the *Sensor Settings* dialog, is used to determine how each sensor is handled during the test process, as far as taking As Found data, performing alignment, and taking As

Left data. Refer to Section 2.2.1, Sensor Settings, for more information on this setting.

There are also many settings on the *SensorCal Options* dialog that affect the test process. Refer to Section 2.1.1, Sensor Cal Options, for more information on these settings.

During a calibration, all test results are recorded immediately in the system's local test results database. This database is used only for temporary storage of test results. Upon completion of a calibration, all test results are moved from the local test results database to the network database. This database is used for permanent storage of test results. All reporting and exporting features of the software are performed against the network database. Refer to Section 2.1.1.4, Database tab, for more details on database locations and configuration.

Also upon completion of a calibration, the data taken from the check standard sensor is automatically exported to a text file. This text file is named "*<model>*-*<serial>*.txt" where *<model>* and *<serial>* indicate the model number and serial number of the check standard sensor. This file is written to the application folder. This file can be imported into a spreadsheet for tracking check standard test results. Refer to Section 5.6, Check Standard Sensors, for more information on the purpose of check standard sensors.

When the test process is complete, a message is displayed. This message also indicates the test results migration status and the check standard data export status. If e-mail features are enabled, and one or more e-mail addresses are defined in the e-mail settings file, the check standard data file will be e-mailed to the defined addresses.

To continue, close the *Test* window. The *Graphs* window will close automatically.

2.2.2.2 Aborting a Calibration

SensorCal provides the ability to abort a calibration while in process. To abort a calibration, click the *Abort* button in the upper right section of the *Test* window. SensorCal will first prompt for verification that the test should be aborted. If instructed to proceed with the action, the calibration process is halted.

SensorCal will not allow the *Test* and *Graphs* windows to be closed while a calibration is in progress. This ensures that all calibration records, regardless of status, contain the necessary information to be reported. The calibration must be aborted before the windows may be closed.

When a calibration is aborted, all test results that were gathered prior to the abortion are moved to the network database. SensorCal never deletes any test results once recorded in the database.

2.3 Printing Reports

SensorCal provides two options for printing test results from a calibration. Printing one or both of the reports can give access to the data and results of the

calibration process. Both options provide the ability to search for test results using various criteria, print single or multiple reports, and preview the reports prior to printing. All reporting features of the software are performed against the network database.

2.3.1 Test Report

The test report is intended to provide details regarding the entire testing process and is intended for in-house use only. A test report contains test results for a single UUT. Each test report contains sections for general test information, test unit detail, test equipment details, As Found and/or As Left test results at each set-point, and sensor constants.

To print a test report, select the *Print Test Report...* option in the *File* menu. The *Print Test Report* dialog is displayed.
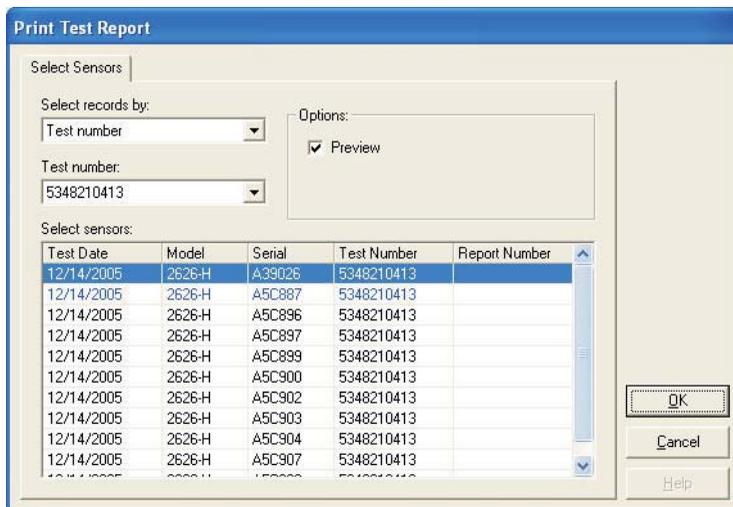
Figure 24 *Print Test Report dialog*

The *Print Test Report* dialog provides a list of sensors to print test reports for. The contents of the list can be changed by selecting different options from the drop-down lists. The *Select records by* drop-down list allows records to be listed based on test number, model/serial number, and report number. The second drop-down list displays options based on the selection in the first drop-down list. Use these drop-down lists to narrow the search results.

The *Select sensors* grid displays a list of all test results that match the selected criteria. Select one or more sensors to print a test report for by clicking on the rows of the grid. Select multiple items by holding down the CTRL key or the SHIFT key while clicking on the rows.

Check standard sensors are highlighted in blue in the grid. Test reports may be printed for check standard sensors just like any other sensor.

If you want to preview the test report on-screen before printing it, check the *Preview* checkbox in the *Options* section. When this option is checked, the software will display each test report in a preview window and give the option of canceling the printing operation or proceeding to print.

Click *OK* to print the test reports for the selected sensors. Test reports are either displayed in the *Print Preview* window or sent to the system's default printer.

2.3.2　Report of Calibration

The Report of Calibration is a formal presentation of the calibration results and is intended to be sent to the customer with the sensor.

To print a Report of Calibration, select the *Print Report of Calibration...* option in the *File* menu. The *Print Report of Calibration* dialog is displayed.
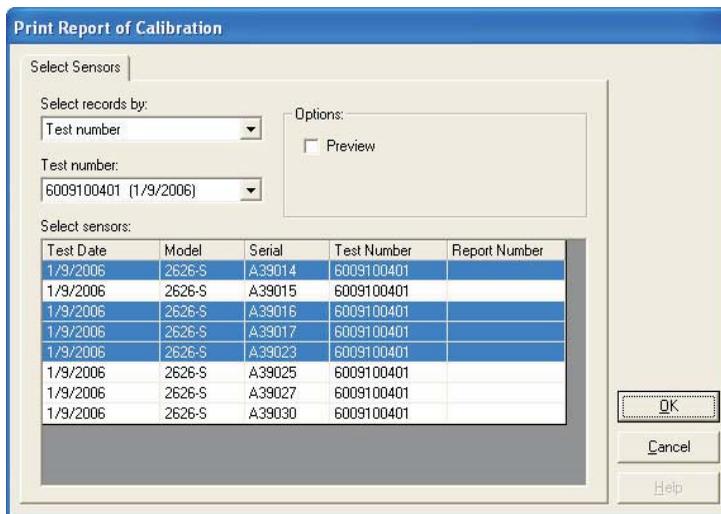
Figure 25　*Print Report of Calibration dialog*

The *Print Report of Calibration* dialog provides a list of sensors to print reports for. The contents of the list can be changed by selecting different options from the drop-down lists. The *Select records by* drop-down list allows records to be listed based on test number, model/serial number, and report number. The second drop-down list displays options based on the selection in the first drop-down list. Use these drop-down lists to narrow the search results.

The *Select sensors* grid displays a list of all test results that match the selected criteria. Select one or more sensors to print a test report for by clicking on the

rows of the grid. Select multiple items by holding down the CTRL key or the SHIFT key while clicking on the rows.

Check standard sensors are not displayed in the grid when printing Reports of Calibration.

If you want to preview the Report of Calibration on-screen before printing it, check the *Preview* checkbox in the *Options* section. When this option is checked, the software will display each Report of Calibration in a preview window and give the option of canceling the printing operation or proceeding to print. Click *OK* to continue.

If a Report of Calibration has not been generated already for the selected sensors, the *Report Settings* dialog is displayed for each sensor to collect additional information required for the Report of Calibration. Otherwise, the Reports of Calibration are either displayed in the *Print Preview* window or sent to the system's default printer.

2.3.2.1   Report Settings

The *Report Settings* dialog is displayed when printing a Report of Calibration for a sensor for the first time.
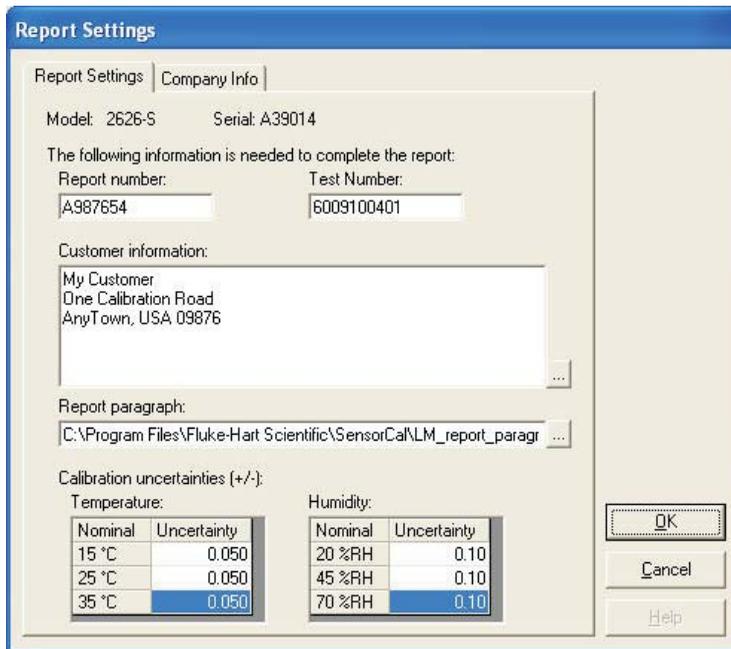

Figure 26   *Report Settings dialog*

The sensor model and serial number for this Report of Calibration are displayed at the top of the dialog on the *Report Settings* tab.

Enter a unique report number for this Report of Calibration in the *Report number* box. SensorCal will check for and prevent the use of duplicate report numbers. Report numbers are limited to 15 characters. The test number is displayed for informational purposes only and is not printed on the Report of Calibration.

Enter the name and address of the customer that this sensor belongs to in the *Customer information* box. To open a text file containing the customer's name and address information, click the *Browse* (…) button to the right of the box.

If you want to print a paragraph of text on the front page of the Report of Calibration, click the *Browse* (…) button to the right of the *Report paragraph* box and select a text file containing the paragraph text to print.

⚠️ *CAUTION: The selected paragraph text will print on the Reports of Calibration for <u>all</u> sensors that were calibrated under the indicated test number. Make sure the paragraph text does not contain information specific to a single sensor. If a Report of Calibration has already been generated for any other sensor that was calibrated with this sensor (same test number), the paragraph text has already been defined and the Report paragraph box and Browse (…) button are disabled.*

Enter the uncertainties for the test results using the *Calibration uncertainties* grids.

⚠️ *CAUTION: Like the paragraph, the uncertainties entered apply to <u>all</u> sensors that were calibrated under the indicated test number. Make sure the uncertainty values entered are not specific to a single sensor. If a Report of Calibration has already been generated for any other sensor that was calibrated with this sensor (same test number), the uncertainty values have already been defined and the uncertainty grids are disabled.*

To select the company name and address to appear at the top of the Report of Calibration as the company that performed the calibration, select the *Company Info* tab. Enter the name and address of the company that performed the calibration in the *Company information* box. To open a text file containing the company's name and address information, click the *Browse* (…) button to the right of the box.

If you want SensorCal to remember the currently entered information and use it on subsequent Reports of Calibration, check the *Save as default information* checkbox.

Click *OK* to print the Reports of Calibration. Reports of Calibration are either displayed in the *Print Preview* window or sent to the system's default printer.

2.4 Exporting Data

SensorCal provides a tool that allows test data to be exported from the network database to a delimited text file. This option can be useful for getting access to the stored values for doing reporting using another tool or for evaluating test results without having to access the database directly. Test data for both standard sensors (UUTs) and check standard sensors can be exported. The format of the export file is different for each type of export performed.

2.4.1 Test Data

To export test data for UUTs, select the *Test Data to File…* option in the *Export* submenu in the *File* menu. The *Export Data to File* dialog is displayed.
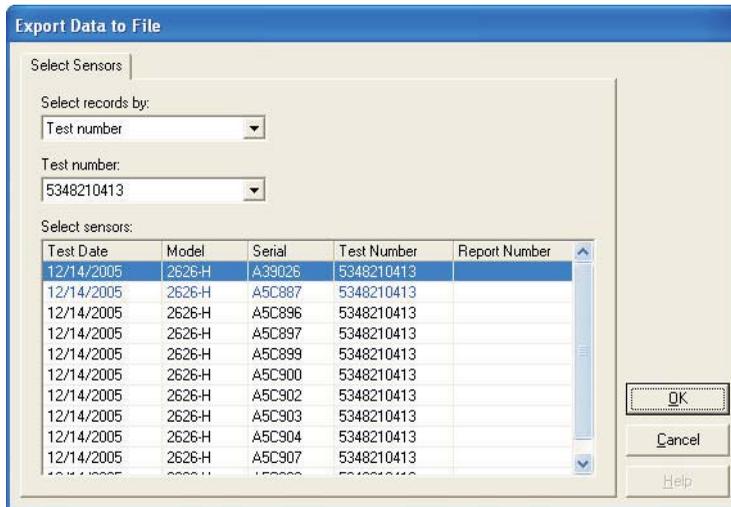
Figure 27 *Export Data to File dialog*

The *Export Data to File* dialog provides a list of sensors to export test data for. The contents of the list can be changed by selecting different options from the drop-down lists. The *Select records by* drop-down list allows records to be listed based on test number, model/serial number, and report number. The second drop-down list displays options based on the selection in the first drop-down list. Use these drop-down lists to narrow the search results.

The *Select sensors* grid displays a list of all test results that match the selected criteria. Select one or more sensors to export test data for by clicking on the rows of the grid. Select multiple items by holding down the CTRL key or the SHIFT key while clicking on the rows.

Check standard sensors are highlighted in blue in the grid. Test data may be exported for check standard sensors just like any other sensor using this feature.

To obtain check standard test data for performing statistical analysis, the format of the export file generated by the *Export Check Standard Data to File* option may be more appropriate.

Click *OK* to export the test data for the selected sensors.

Exported test data files are placed in the *\DataFiles* subfolder located in the application folder. The export file is named "*<model>-<serial>*.txt" where *<model>* and *<serial>* indicate the model number and serial number of the sensor. If a file already exists with this filename, it is overwritten.

2.4.2   Check Standard Data

Check standard data files contain only the measured errors at each test set-point for each test. To export check standard data only, select the *Check Standard Data to File…* option in the *Export* submenu in the *File* menu. The *Export Check Standard Data* dialog is displayed.
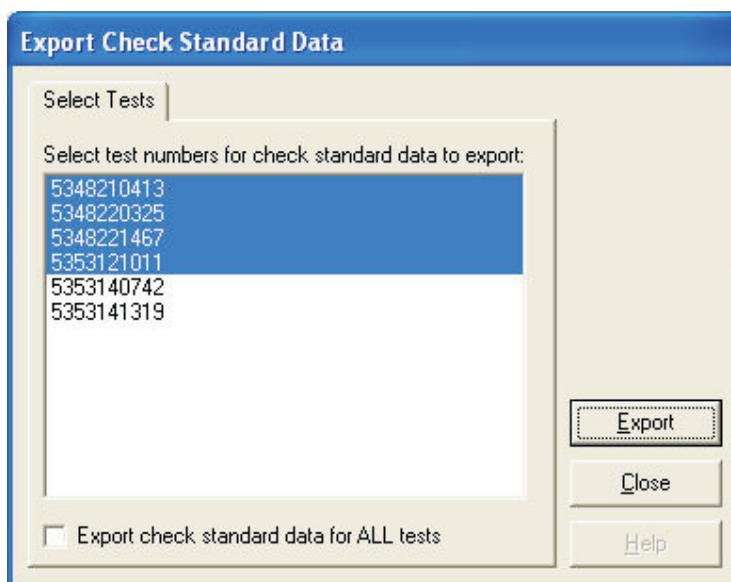
Figure 28 *Export Check Standard Data dialog*

The *Export Check Standard Data to File* dialog displays a list of all tests that have been performed. Each test includes data from a single check standard sensor.

Select one or more tests to export check standard data for by clicking on the test numbers in the list. Select multiple tests by holding down the CTRL key or the SHIFT key while clicking on the test numbers. To select all test numbers in the list, check the *Export check standard data for ALL tests* checkbox.

Click the *Export* button to export the check standard data for all selected tests. The *Browse for Folder* dialog is displayed to allow the destination folder for the exported files to be selected. Select the appropriate location and click the *OK* button.

Exported check standard data files are named "*<model>-<serial>*.txt" where *<model>* and *<serial>* indicate the model number and serial number of the check standard sensor. Data from all tests that used the same check standard sensor are written to the same file. If a file already exists with this filename, it is appended.

Refer to Section 5.6, Check Standard Sensors, for more information on the purpose of check standard sensors.

3 Database Tools

SensorCal provides tools for handling and maintaining the software's databases. These tools can help keep the data storage process operating properly and efficiently.

3.1 Database Maintenance

Periodically it is recommended that maintenance be performed on the SensorCal databases. As the software performs various operations with the database, records are copied, moved, or deleted. These actions affect the way the database allocates space and stores records, leaving the database fragmented. The process of compacting the database reclaims lost or wasted space by re-indexing the records and eliminating the fragmented space. The database maintenance feature in the software will compact the selected database.

To perform database maintenance, select *Compact…* in the *Database* submenu in the *Tools* menu. The *Select Database to Compact* dialog is displayed. Navigate to and select the database to compact and click *Open*.

The compacting process creates a backup of the database before attempting to compact the database, in case there are any problems. Database backups are named *<filename>.nnn* where *nnn* is a sequential number beginning at *000*. If the compact process fails or the database become unreadable, you can revert to the pre-compacted copy of the database by deleting or renaming the current database file *<filename>.mdb*, and then renaming the *<filename>.nnn* file to *<filename>.mdb*. Always select the file with the highest sequential number for *nnn*.

3.2 Migrating Test Data

SensorCal provides a tool for migrating test data from the local database to the network database. This process generally occurs automatically at the conclusion of a calibration. If conditions or situations arise which prevent the migration from occurring, the migration tool will perform the same function.

To migrate test data, select the *Migrate Test Results to Network Database* option in the *Tools* menu. All existing test result records are moved from the local database to the network database.

4   **Power Failure Recovery**

SensorCal is capable of recovering from a power failure. This feature allows the software to resume the calibration process without requiring user interaction. Automatic recovery can save time and keep the calibration process running as efficiently as possible. The calibration process can take up to 32 or more hours to perform. Without this feature, if this process was interrupted by a power failure, the process would have to be restarted, resulting in a significant loss of time.

During a calibration, SensorCal keeps track of the current test state by creating a file in the application folder named *recover.ini*. In the event of a power failure the PC reboots, logs in, and launches the software. If this file exists, SensorCal assumes that a test was in process and attempts to recover the calibration. The calibration is recovered by restarting the test at the last set-point in process regardless of what had been done at that set-point already. The recovery file is deleted when the calibration completes or is aborted.

In order to successfully recover a calibration without any user interaction, there are a few requirements that must be met. These requirements are outlined below. The SensorCal test station computer was originally configured with these settings.

- The PC must be capable of powering up after a power failure. Generally, if supported by the power supply, this option is configurable in the BIOS of the computer.

- The PC must also be setup to logon to Windows® automatically without requiring the user to press CTRL-ALT-DEL and/or enter a user name and password. The AutoLogon utility is provided on the SensorCal CD-ROM to assist in configuring Windows® 2000/XP to do this. Insert the SensorCal CD-ROM and click the appropriate icon to launch the utility. You must be logged onto Windows® as an Administrator in order to successfully use this utility.

- The SensorCal icon must be included in the Startup group. This will ensure that the software is launched once the automatic logon is complete.

⚠ *CAUTION: If you join this computer to your company's network, setting up the computer to automatically logon to Windows® may violate your network security policies. Consult your network administrator before proceeding to do this. The power failure recovery feature of SensorCal will still successfully recover a calibration without any of these steps being implemented, but user interaction will be required.*

There are certain restrictions surrounding the power failure recovery feature. After a power failure all associated test equipment must be powered up. If for some reason an instrument does not power up, the test recovery will fail. A prompt will appear asking if the recovery should be retried. If the problem can

be resolved, the retry option will allow the calibration to be recovered. If the problem can not be resolved, SensorCal will continue to attempt to recover the calibration each time the software launches until the *recover.ini* file has been deleted, either by the software or manually.

If a calibration experiences a power failure and successfully recovers, a note is printed at the top of the test reports for all sensors being calibrated indicating such. The Report of Calibration, however, is not affected.

5 Test Equipment Configuration

The test equipment required by SensorCal to calibrate the temperature/humidity sensors must be configured with specific settings in order to function as the software expects. The following sections indicate the specific setting required for each instrument.

5.1 Humidity Chamber

This system is designed to use a Thunder Scientific Model 2500 Benchtop Humidity Generator (chamber), including models 2500, 2500S and 2500ST. Use of any other chamber is not supported.

Prior to using the chamber, follow the instructions and observe all recommendations in the Installation section of the chamber's Operation and Maintenance Manual. Pay particular attention to the following information:

- Air Supply
- Distilled Water Supply
- Chamber Fluid Filling

In addition to the information found in the chamber's Operation and Maintenance Manual, observe the requirements and recommendations as outlined in the following sections.

Also, refer to Section 1.6.2, Chamber Installation, for more information on interfacing the chamber with the rest of the equipment and system computer.

5.1.1 Settings and Configuration

Certain parameters in the chamber must be set in order to use the chamber in this system. These settings are outlined in Table 4 below.

Table 4 *Humidity Chamber Settings*

Parameter/Item	Setting	Notes
VP(6)	0.75	Expansion valve DT setting (Default setting: 1)
Baud rate	<any>	Set software to use same baud rate as chamber
External regulator	100psi	Located on chamber cart (underneath chamber)
Internal regulator	95psi	Located inside back cover of chamber

The console baud rate and VP(6) settings can be accessed by entering calibration mode using the chamber's built-in menus. When prompted, use the password *2500.1* to gain access to the correct chamber menus. Refer to the chamber's Operation and Maintenance Manual for details on changing parameter values.

Some chambers may work better at some baud rates than others. If, during the calibration process, messages frequently appear in the status bar indicating communication failures with the chamber, try using a different baud rate setting. Refer to Section 2.1.2.2, Chamber tab, to configure the software to the same baud rate as the chamber and test the communications with the chamber.

The compressed air regulators must be set while the compressed air supply is connected to the chamber. The external regulator, located underneath the chamber on the cart, should be set first.

To set the internal regulator, remove the screws from the left back panel of the chamber. The regulator is located in the bottom left corner of the compartment. The chamber must be powered up and operating in RUN mode to properly adjust this regulator. Use extreme caution to avoid electrical shock and other dangers while adjusting this regulator. Replace the back panel when complete.

Also, make sure the chamber is set to display and take temperature readings in Celsius.

5.1.2   Compressed Air Supply

The compressor that is supplied with the chamber may be used as the compressed air supply. However, this compressor has a limited life expectancy. Be sure to read the information in the chamber's Operation and Maintenance Manual regarding maintenance and care of the compressor.

Alternatively, any other compressed air supply may be used. The following requirements and recommendations must be observed when using another source for the compressed air supply for the chamber:

- It is required to have **no less** than 110psi at the external regulator, located on the cart (underneath the chamber), at all times. If this pressure ever drops below 100psi, the chamber's performance and the calibration results may be affected.

- It is recommended that an appropriate dryer and filter be installed on the compressed air line to extract moisture from the air and prevent that moisture from entering the chamber.

- Use the proper compression fittings and hoses as recommended by the chamber manufacturer.

5.1.3   Chamber Fluids

Before using the chamber for the first time, be sure to follow the instructions in the chamber's Operation and Maintenance Manual for filling the chamber's fluid jacket.

Also, it is recommended that the chamber's water tank be at least half full before starting a calibration.

5.2   Sensor Manifold

The sensor manifold is a proprietary fixture specially designed after months of research and testing to calibrate the sensors. The design of the manifold reduces uncertainties and provides as consistent an environment as possible for all sensors, regardless of the sensor's position in the manifold.

Calibration uncertainties can be further reduced by following the procedure outlined in Section 6, Chamber Temperature Profile Procedure, to create a temperature map or profile for the chamber and manifold combination, thus allowing the software to correct for known errors in temperature measurements for each sensor position.

Also, refer to Section 1.6.3, Manifold Installation, for more information on installing the manifold into the chamber.

5.3   Switch/Multiplexer

This system is designed to use a Keithley Model 7001 Switch Mainframe (multiplexer) to enable calibrating up to 10 sensors simultaneously using a single channel of the sensor readout device (logger). Use of any other switch or multiplexer is not supported.

Also, refer to Section 1.6.4, Switch/Multiplexer Installation, for more information on interfacing the multiplexer with the rest of the equipment and system computer.

5.3.1   Settings and Configuration

The GPIB (IEEE) address of the multiplexer must be set. You may use any address between 1 and 30, so long as the address is not being used by any other instrument on the IEEE bus. The GPIB address setting is accessible through the *ADDRESS* option in the *GPIB* menu. Refer to the multiplexer's User's Guide for details on changing this setting.

Also, the multiplexer must be configured to use the card in two-pole mode by setting the *#-OF-POLES* setting in the *CARD CONFIG* menu for the appropriate card slot. The card must already be installed before setting this setting. Refer to the multiplexer's User's Guide for details on changing these settings.

Refer to Section 2.1.2.1, Multiplexer tab, to configure the software to the same IEEE address as the multiplexer and test the communications with the multiplexer.

5.3.2　　Multiplexer Card Wiring

The card used in the multiplexer is a Keithley Model 7011-S Quad 1x10 card. Use of any other switch or multiplexer is not supported.
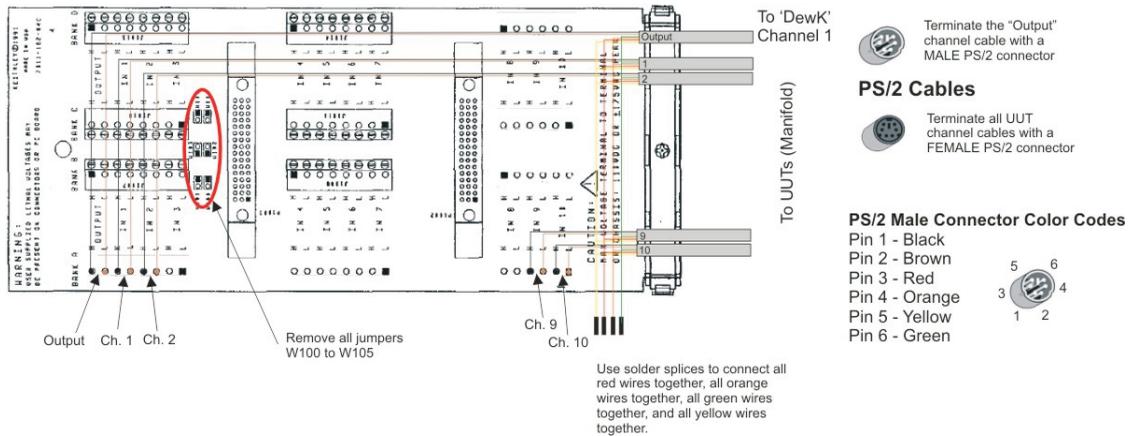

Figure 29　Keithley 7011-S Card Wiring Details

To begin, separate the relay card from the connector card by removing the screw that holds them together. Gently pull the two cards apart.

The card must be configured for two-wire mode. To do this, remove the jumpers W100, W101, W102, W103, W104, and W105 from the connector card.

To wire the card, you need eleven PS/2 cables. The length of the cables is not important, as long as they are sufficient to make all necessary connections. Six foot cables are recommended.

Cut the female end off of a PS/2 cable and connect the black (pin 1) and brown (pin 2) wires to the *H* and *L* points respectively of the *Bank A* terminal block connectors labeled *OUTPUT*. Attach a label to this cable identifying it as the OUTPUT cable.

Cut the male ends off of the other ten PS/2 cables and connect the black (pin 1) and brown (pin 2) wires to the *H* and *L* points respectively of the *Bank A* terminal block connectors labeled *IN 1* through *IN 10*. Attach a label to each cable to identify which input channel each cable is connected to.

Then connect the red (pin 3) wires from all input and output cables together using a butt splice or other appropriate connector. Repeat this process for the orange (pin 4), yellow (pin 5) and green (pin 6) wires.

Run all PS/2 cables through the strain relief connector. Reconnect the relay card and the connector card and replace the screw to hold them together.

Insert the card into one of the slots in the back of the multiplexer. Either slot may be used so long as the software is configured properly.

5.4 Thermo-hygrometer Readout/Logger

This system is designed to use a Fluke/Hart Model 1620 Thermo-Hygrometer readout (logger) to take readings from the UUT and check standard sensors. Use of any other logger to take readings from the sensors is not supported.

Also, refer to Section 1.6.5, Thermo-hygrometer Readout/Logger Installation, for more information on interfacing the logger with the rest of the equipment and system computer.

5.4.1 Settings and Configuration

To configure the logger for use with this system, the communication, alarms, and password protection settings need to be configured. All password protection and alarm settings in the logger should be disabled (set to OFF). The communication settings need to be set as follows:

- Set BAUD (baud rate) to any setting
- Set LF (linefeed) to ON
- Set ECHO to OFF
- Set PRINT to OFF

These settings can be accessed by entering the logger's built-in menus. Refer to the logger's User's Guide for details on changing these settings.

Also, make sure the logger is set to display and take temperature readings in Celsius.

Refer to Section 2.1.2.5, Logger tab, to configure the software to the same baud rate as the logger and test the communications with the logger.

5.5 Temperature Reference Readout and Probe

This system is designed to use a Fluke/Hart Model 1504 readout (readout) and a Model 5610-6 thermistor probe to serve as the temperature reference for the system. All temperature reference measurements used by the system are taken from this readout and probe. Use of any other readout is not supported. Other thermistor probes may be used so long as they have similar physical dimensions and characteristics as the indicated probe.

Also, refer to Section 1.6.6, Temperature Reference Readout Installation, for more information on interfacing the readout and probe with the rest of the equipment and system computer.

5.5.1   Settings and Configuration

The GPIB (IEEE) address of the readout must be set. You may use any address between 1 and 30, so long as the address is not being used by any other instrument on the IEEE bus. Also, make sure the *EOS* (end of string) setting is set to *LF* (linefeed) to indicate how GPIB commands and responses are terminated. The GPIB settings are accessible through the readout's menus. Refer to the readout's User's Guide for details on changing these settings.

The calibration coefficients for the thermistor probe are located on the Report of Calibration that came with the probe. These coefficients must be entered into the readout so that the readout can correctly convert resistance readings from the probe into temperature. Refer to the readout's User's Guide for details on entering probe coefficients into the readout.

Also, make sure the readout is set to display and take temperature readings in Celsius.

Refer to Section 2.1.2.3, Temp Ref tab, to configure the software to the same IEEE address as the readout and test the communications with the readout.

5.6   Check Standard Sensors

This system is designed to use check standard sensors for the purpose of collecting data for statistical analysis and control. A check standard sensor is treated just like any other sensor, except the software never performs an alignment on this sensor (i.e. new calibration constants are never calculated). There is no difference, physical or otherwise, between a check standard sensor and any other sensor. Any sensor may be used. However, one sensor for each type of calibration has been designated and labeled as the check standard sensor for this system.

The system is required to have one check standard sensor for each type of calibration being performed: one standard accuracy (-S) sensor and one high accuracy (-H) sensor. The standard accuracy check standard sensor should be used with all standard accuracy calibrations, and the high accuracy check standard sensor should be used with all high accuracy calibrations. Running one common sensor through all calibrations of the same type produces sets of data that can be analyzed and monitored. Significant deviations in check standard data from one test to another can help identify problems with the systems that may affect the quality and precision of the calibration results.

SensorCal does not include any tools to directly monitor or analyze check standard data. SensorCal does provide a means to export check standard data to delimited text files that can be imported into spreadsheet or statistical analysis software.

5.7   "Mock" Sensors

This system is designed to calibrate up to 10 sensors simultaneously. In cases where smaller batches of sensors need to be calibrated, one set of 9 "mock" sensors is provided for each type of calibration. These sensors should be used to fill in the remaining positions in the manifold when calibrating a batch of fewer than 10 sensors.

There is no difference, physical or otherwise, between a "mock" sensor and any other sensor. Any sensor may be used as a "mock" sensor. However, one set of 9 sensors for each type of calibration have been designated and labeled as "mock" sensors for this system.

Each sensor generates a small amount of heat. The heat that each sensor generates affects the measurements of that sensor and all other sensors in the manifold. In order to maintain consistency when calibrating batches of sensors of varying numbers, use the "mock" sensors to fill every position in the manifold. This assures that the same amount of heat is being generated regardless of the number of sensors being calibrated.

When setting up a calibration, "mock" sensors may, and should be, disabled to prevent the software from taking measurements from and creating test results records for these sensors in the database. Refer to Section 2.2.1, Sensor Settings, for more information on disabling sensors.

6   Chamber Temperature Profile Procedure

SensorCal provides some features for improving (reducing) the uncertainties of the calibration process. These features are optional but may be used if desired. SensorCal will perform valid calibrations regardless of whether these features are used or not.

One of these features involves measuring and calculating temperature errors for each position in the manifold by mapping, or profiling, the manifold at the different set-points used by the calibration process. These errors, or offset values, can then be entered into the software's database. During a calibration, the software can then lookup and apply the known offset values to each sensor's measured data to compensate for the known errors.

A procedure and spreadsheet is provided on the SensorCal installation CD-ROM to facilitate the calculation of offset values. Insert the SensorCal CD-ROM and click the appropriate icon to locate the chamber temperature profile procedure and spreadsheet.

7   SensorCal Databases

SensorCal utilizes two databases: *SCSetup.mdb* and *SCResults.mdb*. By default, these databases are installed locally in the application directory (typically *C:\Program Files\Fluke-Hart Scientific\SensorCal*). A second copy of the *SCResults.mdb* database is also installed to the *\Archive* subfolder. The databases can be relocated if desired, as long as the software is configured with the appropriate path for each database. Refer to Section 2.1.1.4, Databases tab, for more information on database location settings.

Each of the databases serves a different purpose. *SCSetup.mdb* contains tables to store setup information that is not subject to frequent changes. This information includes the chamber offsets and calibration set-point definitions. The *SCResults.mdb* database in the application folder contains tables to temporarily store test results information and data while a calibration is being performed. Information stored in this database includes details of the test, test unit, and test equipment as well as the readings and calibration constants for each test unit.

In addition to these local databases, SensorCal utilizes a network database. The network database follows the same structure as the local *SCResults.mdb* database but is not a duplication of information. Once a calibration completes successfully or is aborted, the test results records are copied to the network *SCResults.mdb* database and deleted from the local database. The network database is the permanent storage location for test results information. Options in the software to print or export data only look to the network database to find test records. The location of the network database is configured in the same manner as the local databases and may be moved to another location if desired.