Specification Template for Calibration of Temperature- and Humidity-Measuring Equipment

Environmental sensors are used to characterize properties of indoor or outdoor spaces, such as temperature, humidity, or air quality. Sensors or reference standards need to be calibrated periodically to ensure that their use yields accurate measurements. Calibration needs, however, vary in sophistication, based on user and use-case requirements. The specification template presented in **Part A** of this document can be used for requesting calibration services and should be tailored to meet each user’s needs.

To illustrate, **Part B** of this document provides an example implementation of the template specification, reflecting the planned usage of the device to be calibrated.

For more information, see the report, [*Specifying Calibration of Environmental Sensors*](https://www.energy.gov/eere/ssl/downloads/specifying-calibration-environmental-sensors).

[Part A: Specification Template for Calibration of Equipment Used to Measure Temperature and Humidity](#PartA)

[Part B: Example Specifications for Calibration of Equipment Used to Measure Temperature and Humidity](#PartB)

Produced for the U.S. Department of Energy, Energy Efficiency and Renewable Energy, by the Pacific Northwest National Laboratory, Richland, Washington 99352

Part A: Specification Template for Calibration of Equipment Used to Measure Temperature and Humidity

**Section 1: Specifications for calibration of multi-sensor node**

Requirements for calibration of the multi-sensor node described in Section 2 are as follows:

1. Calibration shall be performed by an ILAC MRA signatory-accredited laboratory and within its scope of accreditation to ISO/IEC 17025.
2. Report shall include data for each calibration point as detailed in sections 7.8.2 (common requirements for reports) and 7.8.4 (specific requirements for calibration certificates) of ISO/IEC 17025:2017 (e.g., including uncertainties), with conditions readily discernible from text.
3. Report shall indicate calibration interval per manufacturer guidance.
4. Report shall express calibration in the form of a calibration table.
5. Verification pass/fail (out of tolerance) criteria shall be per the calibrated-equipment manufacturer’s accuracy specifications, at the manufacturer-recommended calibration interval.
6. If adjustment or repair was required, report shall state that this was performed and provide before/after values (i.e., as-found and as-left).
7. Configuration
8. Equipment shall be oriented (provide additional details here to ensure proper orientation during calibration).
9. Operate (provide details here regarding modes/settings).
10. See Section 3 for instructions regarding installation and connectivity.
11. Measuring equipment shall be calibrated at the following calibration points:
12. Dry-bulb temperature measurement shall be calibrated at the (specify number here) points in Table A1.
13. Relative-humidity measurement shall be calibrated at the (specify number here) points in Table A1.
14. Calibration specifications for the other sensor types (list here if applicable) are in development; please exclude them from any price quotes.
15. Adjustment
16. The equipment (indicate “can” or “cannot”) be adjusted for both temperature and relative humidity; see Section 2 for equipment specifications and Section 3 for adjustment instructions.
17. The equipment shall be adjusted if found to be out of tolerance relative to manufacturer accuracy specifications; provide separate quotes for calibration with and without adjustment (delete bullet if adjustment isn’t possible).

**Section 2: Multi-sensor node performance specifications (for reference)**

The equipment to be calibrated is a multi-sensor device, manufactured by (company name here), incorporating the sensors described in Table A2.

Access to sensor datasheets and user manuals can be provided separately. The integrated node measures approximately (*quantity value here*) tall, (quantity value here) wide, and (quantity value here) deep (see Figure A1).

Additional features:

* (describe connectivity means here; e.g., WiFi)
* (describe indication/reading means here; e.g., LCD)
* (describe input power means here; e.g., 120 V power supply with 4-foot cord)

|  |
| --- |
| (*insert photo of multi-sensor node here*) |

Figure A1. Photo of measuring equipment to be calibrated.

**Section 3: Multi-sensor node connectivity, software, and adjustment instructions (for reference)**

General notes:

* The information linked from this section pertains to our equipment’s software only; for hardware information, see Section 2.

Instructions:

1. *(E*.g., describe how to put equipment on the local WiFi network – point to available documentation rather than duplicating it here)
2. *(E*.g., describe how to configure the equipment over the network, again pointing to documentation where available)
3. *(E*.g., describe how to adjust the equipment if it is found to be out of tolerance, again pointing to documentation where available)

Table A1. Measurement of dry-bulb temperature and relative humidity at 1.0 atm (revise number of values for each quantity as needed)

|  |  |  |
| --- | --- | --- |
| Calibration point | Dry-bulb temperature (°C) | Relative humidity (%) |
| A. B. C. | (value one)(value two)(value three) | (value one) |
| D. E. F. | (value one)(value two)(value three) | (value two) |
| G. H. I. | (value one)(value two)(value three) | (value three) |

Table A2. Relevant equipment characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment make/model | Measured quantity | Specs stated on datasheet | Notes |
| (complete ordering info here) | Dry-bulb temperature | (list performance specs, range, etc.) |  |
| Relative humidity | (list performance specs, range, etc.) |  |

Part B: Example Specifications for Calibration of Equipment Used to Measure Temperature and Humidity

The following example illustrates the intended use of the specification template provided in Appendix A. A set of nine test cases shown in Table B1 defines the range of intended use of a particular reference environmental sensor. Given the stated range of intended use, the following specifications were developed. Four commercial U.S. calibration laboratories with scopes of accreditation that cover calibration of DBT- and RH-measuring equipment were identified.

**Section 1: Specifications for calibration of multi-sensor node**

Requirements for calibration and adjustment of the multi-sensor node described in Section 2 are as follows:

1. Calibration shall be performed by an ILAC MRA signatory-accredited laboratory and within its scope of accreditation to ISO/IEC 17025.
2. Report shall include data for each calibration point as detailed in sections 7.8.2 (common requirements for reports) and 7.8.4 (specific requirements for calibration certificates) of ISO/IEC 17025:2017 (e.g., including uncertainties), with conditions readily discernible from text.
3. Report shall indicate calibration interval per manufacturer guidance.
4. Report shall express calibration in the form of a calibration table.
5. Verification pass/fail (out of tolerance) criteria shall be per the calibrated-equipment manufacturer’s accuracy specifications, at the manufacturer-recommended calibration interval.
6. If adjustment or repair was required, report shall state that this was performed and provide before/after values (i.e., as-found and as-left).
7. Configuration
8. Equipment shall be oriented as used, with external probe below unit as shown in Section 2.
9. Operate SCD30 in continuous measurement mode, with measurement rate at 2 s.
10. See Section 3 for instructions regarding installation and connectivity.
11. Measuring equipment shall be calibrated at the following calibration points:
12. Dry-bulb temperature measurement shall be calibrated at the nine points in Table B1.
13. Relative humidity measurement shall be calibrated at the nine points in Table B1.
14. Calibration specifications for the other three sensor types (CO2, TVOC, PM2.5) are in development; please exclude them from any price quotes.
15. Adjustment
16. The equipment can be adjusted for both temperature and relative humidity; see Section 2 for equipment specifications and Section 3 for adjustment instructions.
17. The equipment shall be adjusted if found to be out of tolerance relative to manufacturer accuracy specifications; provide separate quotes for calibration with and without adjustment.

**Section 2: Multi-sensor node performance specifications (for reference)**

The equipment to be calibrated is a custom multi-sensor node, manufactured by Temco Controls, incorporating the sensors described in Table B2. The Temco Controls [Air Lab & PM2.5 Particle Sensor](https://temcocontrols.com/shop/air-particle-quality-sensor) serves as the hardware platform for the custom multi-sensor node.

Access to sensor datasheets and user manuals can be provided separately upon request. Notably, rated performance pertains to sensors prior to node integration (i.e., design-in). The integrated node measures approximately 6 inches tall, 3 inches wide, and 1 inch deep (see Figure B1). The external probe is for the SCD30.

Additional features:

* Light sensor, no specs available, not to be calibrated
* External microphone potentially included in some nodes, not to be calibrated
* Wi-Fi connectivity
* LCD display may remain on at all times for calibration procedures, or may be configured to automatically turn off after a certain period of time
* Mean Well GSM12U power supply, 120 VAC input with cord 1.8 meter in length.

Figure B1. Photo of measuring equipment to be calibrated.

**Section 3: Multi-sensor node connectivity, software, and adjustment instructions (for reference)**

Instructions:

* To get the nodes onto your WiFi network, use the Android-only [app](https://temcocontrols.com/wp-content/uploads/sites/4/2019/08/24esptouch.zip). Instructions for the Android-based WiFi set-up can be found on page 5 of [this manual](https://temcocontrols.com/wp-content/uploads/sites/4/2020/01/AirLabPM2.5ParticleSensor-1.pdf).
* Use the T3000 Windows [software](https://temcocontrols.com/ftp/software/09T3000Software.zip) to connect to the nodes from your computer over the network, and implement adjustment. Instructions for implementing adjustment via the T3000 Windows software can be found on pages 96-97 of [this manual](https://temcocontrols.com/ftp/file/SoftwareManual.pdf). The System Tree in the T3000 software, in which the sensor nodes should be listed if set up correctly via the Android app, is shown and detailed on page 19. The computer running the T3000 software must be on the same WiFi network the Android device was on when it was used to program the sensor nodes.

Table B1. Measurement of dry-bulb temperature and relative humidity at 1.0 atm

|  |  |  |
| --- | --- | --- |
| Calibration point | Dry-bulb temperature (°C) | Relative humidity (%) |
| A. B. C. | 5 25 45 | 30 |
| D. E. F. | 5 25 45 | 60 |
| G. H. I. | 5 25 45 | 90 |

Table B2. Sensors incorporated in multi-sensor node

|  |  |  |  |
| --- | --- | --- | --- |
| Sensor make/model | Measured quantity | Specs stated on datasheet | Notes |
| Sensirion SCD30 CO2 and RH/T Sensor Module | Dry-bulb temperature | Measurement range  Accuracy  Repeatability  Response time  Accuracy drift |  |
| Relative humidity | Measurement range  Accuracy  Repeatability  Response time  Accuracy drift |  |
| CO2 | (see datasheet) | Diffusion-based (no pump) |
| Sensirion SGP30 Multi-Pixel Gas Sensor | TVOC | (see datasheet) | Used in all 10 nodes  Automatic humidity compensation |
| Ion Science PPB MiniPID 2 #MP3SBLBBU2 photoionization detection (PID) sensor | TVOC | (see datasheet) | Used in 2 of 10 nodes  Apparently doesn’t need/use humidity compensation |
| Sensirion SPS30 Particulate Matter Sensor | PM2.5 | (see datasheet) |  |