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Everyone knows that all acoustic and vibration instrumentation must be calibrated but not everyone knows what that means or the standards behind it. It is our hope that this guide helps all users to understand what goes into calibration and what sets Scantek, Inc. apart from the rest.

Overview

*Calibration* is defined as, “operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.”

In other words, the calibration determines the error values of a measuring instrument (and if necessary determines other metrological properties as well). Therefore the result of a calibration service must be a detailed test report, which Scantek provides at no extra cost.

According to this definition, the calibration certificate is not required to provide a statement about the compliance of the instrument with accepted specifications. However, in order to help users, Scantek, Inc. also provides a verification, finalized with a “pass/fail” notice, in the terms defined by ISO 17025. If reliable specifications are not available, then no statement of compliance is made, or Scantek defined tolerances are applied.

Calibrations *may* include adjustments to the instrument to correct any deviation from the value of the standard, but this is not covered by the definition of the service. These adjustments are always reported by our laboratory.

Traceability

*Metrological Traceability* is defined as “property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.”

It is important to note that traceability is the property of the result of a measurement, not of an instrument or calibration report or laboratory. Following any one particular procedure or using special equipment does not achieve traceability. Merely having an instrument calibrated, even by NIST, is not enough to make the measurement result obtained from that instrument traceable.

VIM¹: “Note 7: The ILAC² considers the elements for confirming metrological traceability to be an unbroken metrological traceability chain to an international measurement standard or a national measurement standard, a documented measurement uncertainty, a documented measurement procedure, accredited technical competence, metrological traceability to the SI, and calibration intervals (see ILAC P-10:2002).”

The metrological traceability chain includes the “sequence of measurement standards and calibrations that is used to relate a measurement result to a reference.”³

There are several key elements Scantek laboratory implemented to achieve and maintain traceability. These include:

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1 International vocabulary of metrology — Basic and general concepts and associated terms (VIM-JCGM 200:2008)
2 US National Institute of Standards and Technology
3 ILAC: International Laboratory Accreditation Cooperation organization
• Reference standards calibrated directly by national labs, such as NIST, NPL England or PTB Germany.

• Proven traceable calibrations for all test instruments used

• Validated procedures and test methods for all tested parameters

• Controlled measurement conditions

• Documented uncertainties, which are reported with each measurement

• Internal measurement assurance\(^4\) program that maintains the accuracy of the standards and of the measurements provided

• Competent, factory trained personnel to the calibrations.

Accredited calibration services
Through the accreditation process, Scantek laboratory was verified that it has an appropriate quality management system and can properly perform the test methods and calibrations according to their scopes of accreditation.

“NVLAP\(^5\) accreditation covers both the management system of a laboratory and the technical capabilities of a laboratory. The assessment of laboratories is performed to check compliance with the requirements of ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories. NVLAP, as a member of the International Laboratory Accreditation Cooperation (ILAC) and a signatory to the ILAC Mutual Recognition Arrangement, performs the assessment and offers accreditation services in conformance with the requirements of ISO/IEC 17011, Conformity assessment - General requirements for accreditation bodies accrediting conformity assessment bodies. Upon satisfactory assessment and successful completion of proficiency testing (where applicable), the laboratory is issued a Certificate of Accreditation along with a Scope of Accreditation listing the test methods or calibration parameters that the laboratory is accredited to perform. The NVLAP accreditation period is one year. To renew its accreditation, a laboratory must demonstrate that it continues to satisfy all NVLAP requirements for accreditation.\(^6\) (http://www.nist.gov/nvlap/accreditation-vs-certification.cfm)

Only the calibration services audited by NVLAP are reported by Scantek as accredited services. This gives the highest degree of confidence that the measurements are accurate and traceable. The calibration documents issued for these services bears the NVLAP logo.

A calibration certificate and test report having the NVLAP logo may contain tests that are not covered by the scope of accreditation. These tests are individually identified as, "not covered by the current NVLAP accreditation."

Periodic calibrations
According to OIML\(^6\) the calibration services are divided in two categories:

• Pattern evaluation (type testing):
  Testing to ascertain that an instrument model entirely satisfies the requirements of the applicable standards

• Verification (periodic calibration)
  Testing to confirm that the performance of a particular instrument has not changed significantly from that determined in the initial tests

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\(^4\) NIST definition of Internal measurement assurance program: a “program of sufficient complexity, within an organization, to provide credibility to the measurement uncertainty and measurement result for which traceability is to be established. An internal measurement assurance program usually involves monitoring the performance (e.g., stability, reproducibility) of the instrument, standard, or measurement system, both before and after it is characterized, calibrated, or used to obtain the traceable measurement result.” (http://www.nist.gov/traceability/suppl_matls_for_nist_policy_rev.cfm#assure)

\(^5\) National Voluntary Accreditation Program (part of NIST)

\(^6\) Organisation Internationale de Métrologie Légale (International Organization of Legal Metrology)
Scantek, Inc. specializes in periodic calibration for sound and vibration measuring instrumentation. For these units, some of the tests necessary for the pattern evaluation can also be provided, at reference conditions only.

In order to ascertain that a meter still meets the applicable standards or specifications, one can perform all possible tests or just test the main parameters. The reduced tests may not catch the out-of-tolerance conditions, reducing the confidence in the measurement results as shown in Figure 1.

![Calibration intervals](image)

**Figure 1:** Influence of the amount of tests or test points on the confidence of the calibration results. a. Amount of tests recommended by the applicable standards; b. Reduced tests

Newer standards are moving to include a list of the required tests that should be performed for the periodic calibrations.

**Calibration intervals**

As required in ISO 17025, Scantek, Inc. does not provide a calibration interval on the calibration stickers or certificates unless specified in writing by the customer and agreed to by both parties. We can assist customers establish their own calibration intervals based on our experience and calibration history of similar instruments.

Calibration intervals can be based on manufacturer recommendations, calibration history or other factors. Manufacturer recommendations rarely cite studies as to why the calibration interval was selected. Calibration histories can be used to set the calibration interval if a drift or decreased accuracy over time is observed. For electronic equipment this is rarely the case. Finally, calibration intervals can be based on a variety of other factors, which include:

- The age of the unit in comparison to the estimated lifetime of the class of instruments
- Calibration results for instruments grouped by model and manufacturer
- Conditions of use such as risk of mishandling, overload, hostile environment, maintenance/cleaning
- Sensitivity of the instrument parts to hostile environment. For example, the microphone is far more sensitive and fragile than the instrument itself
- Costs incurred if measurements are performed with an out-of-tolerance unit, such as fees, damage repair, or cost of having to repeat the tests
- Requested accuracy
- Calibration costs and frequency of use of the unit. While the lack of use does not give assurance that the unit is within tolerance, it is also true that it may not be efficient to calibrate often.

Most often, for modern high quality instruments, the frequency of the periodic tests is only determined by the need to obtain the proof or the confidence that the instrument is within its known specifications.

As an example of how an organization could determine a calibration interval that meets its needs we can look at Scantek, Inc. Differentiated
calibration intervals were established, in parallel with checks of functionality after each field measurement. The more sensitive instruments like calibrators, microphones and accelerometers are calibrated more frequently (9-12 months) than the electronic instruments (1-1.5 years). Very new and very old units are checked every year. These intervals are updated if a calibration reveals an out-of-tolerance condition.

**Calibration services provided by Scantek, Inc. Calibration Laboratory**

When multiple standards (international and national) are applicable, we ask the customer to choose the standard they would like us to use.

**Current and applicable calibration standards for sound level meters, dosimeters, and analyzers**

*US national standards:* 7

- ANSI S1.4: 1983 *American National Specification for Sound Level Meters*
- ANSI S1.43: 1997 *Specifications for Integrating-Averaging Sound Level Meters*

*International standards:*

- IEC 61672-2: 2006 and 2013 *Electroacoustics – Sound level meters. Part 3: Periodic tests (which we use for periodic calibration)*

The first edition of the series of three IEC 61672 standards replaced the old standards IEC 651: 1979 "Sound level meters" and IEC 804: 1985 "Integrating-averaging sound level meters" (which were very similar in requirements with ANSI S1.4 and ANSI S1.43 respectively). When needed, we still can provide testing to these old IEC standards.

The 2013 edition of the IEC 61672 series of three standards was recently adopted as national standard in US.

For testing the filters we use the:

- IEC 61260: 1995 *Electroacoustics - Octave-band and fractional-octave-band filters* (which is equivalent to ANSI S1.11) and
- IEC 225: 1966 (for very old, analog instruments.)
- IEC: 61260-1: 2014 *Electroacoustics - Octave-band and fractional-octave-band filters - Part 1: Specifications* – which was also adopted recently as a national standard. Calibration service according to this standard will be offered by the end of 2014.

For dosimeters, we use a combination of tests from the standards applicable to sound level meters and from:

- IEC 61252: 2002 *Electroacoustics - Specifications for personal sound exposure meters*, or
- ANSI S1.25: 1991: *Specifications for personal noise dosimeters*

In selecting the standard to test to, one needs to consider:

- The specifications and the manufacturers claims for the instrument/system
- The requirements of the test standards applicable for the intended use of the instrument/system
- The requirements of the customers or auditors of the instrument owner.

**Level of Calibration**

For sound level meters, dosimeters, and analyzers Scantek, Inc. has several levels of accredited calibration services, to meet various needs of the customers.

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7 For the test performed according to the IEC 651/8904 or ANSI S1.4/S1.43, we are following the guidelines given in OIML R 58 and OIML R 88.
As required by the standards, these instruments are tested as systems, including the microphones and preamplifiers. All components are listed on the Calibration Certificate. A detailed list of tests included in each service is found on the calibration page of the company website. The customer may choose between:

**Standard calibration service:** Acoustical and electrical signals are used to thoroughly test all the functions and features of the instrument to meet all of the requirements of the standards.

The standard calibration provides the highest degree of confidence that the unit complies with the necessary specifications

**Basic calibration:** Reduced number of tests focusing on the main functions of the instrument. Acoustical only or both electrical and acoustical signals may be used.

The measurement uncertainty of the basic calibration tests is larger than that for the tests included in the standard calibration. Additionally, as shown in the periodic calibration section, there is a higher risk that an out-of-tolerance condition is not discovered.

**Manufacturer level calibration:** Limited selection of acoustical tests verifies the accuracy of the main measured parameter within the frequency domain.

Manufacturer level calibration is used when there are only a few parameters specified, or some parameters are in conflict with the standards requirements. This calibration is similar to the one provided by the manufacturer for these instruments.

**Extended Calibration Service:** Dedicated only to the pattern evaluations. The content of this service has to be established for each case.

**Customized calibration/test services** can be developed upon request. These can be selected from the existing tests without modifications, by customizing tests or by developing new ones. If agreed upon, the adapted or new procedures can be developed according to the requirements of Scantek, Inc.’s Quality System and be submitted to an internal audit. Traceability of the test results can only be claimed once all of the above steps are complete.

**Calibration of multi-channel instruments based on PC and data acquisition boards**

To reduce the calibration cost of multi-channel systems, Scantek, Inc. created a protocol to fully test both the software and hardware while avoiding redundant tests. We fully test one channel according to the selected standard, and then only perform the tests focused on the hardware for the rest of the channels.