Keysight Technologies
Getting The Calibration You Need

If your organization is like most technology companies, test equipment is an important part of ensuring the quality and performance of your end products. One of the fundamental values of test equipment is the confidence you gain from the measurements–and pass/fail decisions–they produce.

The source of that confidence is the specified accuracy of each instrument, and the foundation of that accuracy is calibration. Ultimately, the bedrock beneath that foundation is the service provider you select to calibrate your instruments.

Application Note

KEYSIGHT TECHNOLOGIES

A Practical Example

The concept of getting the calibration you need has real-world implications. Recently, one of our customers shared its first-hand experience with calibration providers. The company was using a variety of Keysight Technologies, Inc. equipment to verify specific parameters and specifications in a range of end products. At the time, they were relying on a third-party provider that had been the lowest-cost bidder for calibration services.

As a wave of instrument calibrations came due, the company asked Keysight to help interpret the trace reports that accompanied each instrument. Working with the customer's quality team, our specialists helped identify the specific parameters that could actually be tested with the standards listed in the trace report. The result: Several key specs either couldn't be tested or weren't being tested. Consequently, the customer's technical staff performed additional audits that revealed more problems.

In the aftermath, the customer switched to Keysight as its calibration provider. As the original equipment manufacturer, Keysight is able to test more parameters and more points, and perform adjustments that bring out-of-alignment instruments back into spec. As a result, the customer is now receiving calibration services that meet or exceed the level of quality it expects in its test systems and end products.

A quick look at calibration

Calibration is the process of measuring the actual performance of an instrument-under-test (IUT) using lab instruments that have significantly better performance than the IUT. The performance of every lab instrument must be traceable to International System (SI) units through a national metrology institute such as NIST, NPL or BIPM.

Calibration involves more steps than you might imagine, and the overall process is diagrammed in Figure 1. Performance tests compare the instrument's actual performance to published (i.e., "data sheeted") specifications. In the ideal case, the service provider will test the performance corresponding to all data-sheeted specifications, for all installed options, every time. If the instrument passes all tests, the process is concluded: The instrument is within specification and you can use it with confidence.

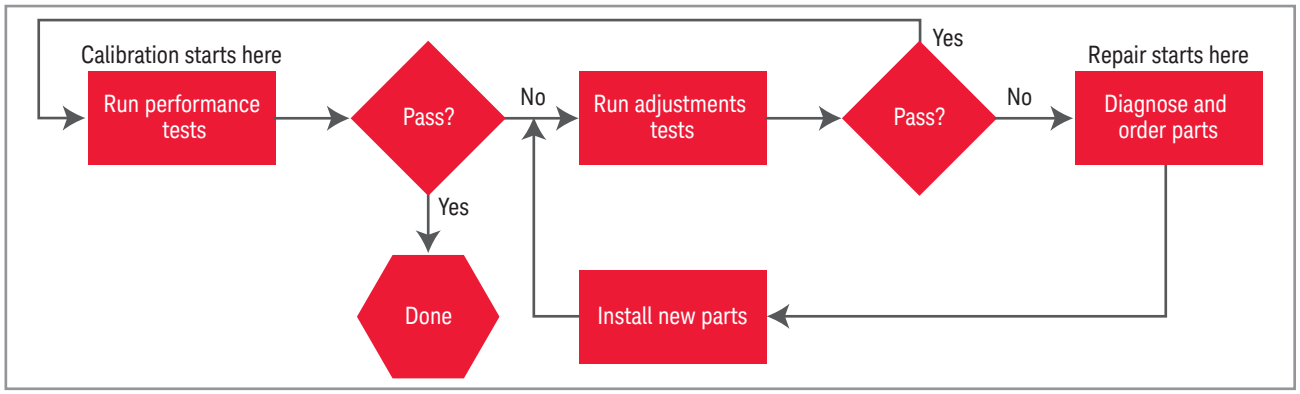

Figure 1. Flow diagram for the calibration process, including repair (if needed).

If the instrument is observed to be out-of-specification, the ideal case is for the service provider to perform adjustments and then re-test the instrument. As shown in the diagram, the process either loops back and starts over or, for an instrument that cannot be adjusted into spec, detours to the "hardware repair" path. Repair begins with a diagnosis of the problem and the ordering of necessary parts. Once the repair has been completed, adjustments are performed and the calibration process loops back to the performance tests. After the instrument passes all performance tests, it is once again ready to make accurate measurements. To minimize turnaround time and manage cost, the service provider should be able to perform adjustments and repairs in-house (i.e., without sending the instrument to another service provider).

Selecting a suitable service provider

Ensuring that you get the calibration you need has several important dimensions. To help you map out your requirements, the rest of this paper presents an approach that is illustrated in Figure 2. It starts with a three-step process that will help highlight your most important calibration needs (first three boxes in Figure 2). Next is a set of short checklists that will help you evaluate potential service providers and select the one best-equipped to meet your specific needs (yes/no loop in Figure 2).

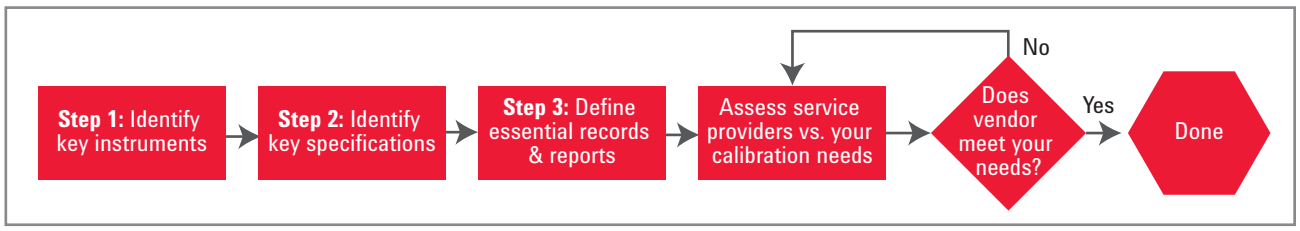

Figure 2. Flow diagram of a process that will help ensure you get the right calibration for your needs.

Identifying needs and defining documentation

The starting point for getting the right calibration is identifying your most important requirements. This has three steps:

1. Identify your key instruments
2. Identify the key specifications for each of those instruments
3. Define the types of records and reports you need to document the calibration status of each important instrument and specification

Let's take a closer look at each of these.

Step 1: Identify key instruments

Every piece of test equipment was purchased for a reason: it may have been an essential feature, capability, measurement, or specification. In most cases, you can quickly identify the high-impact instruments your organization depends on. Examples include high-performance RF or microwave instruments such as signal analyzers, network analyzers, signal generators, sampling or real-time oscilloscopes, and high-precision digital multimeters.

Step 2: Identify key specifications

Once you've identified the most important instruments it's time to pinpoint the key specifications each one must meet to help ensure the success of your enterprise. A good starting point is to compile a list of requirements for each instrument. Examples include amplitude accuracy or displayed average noise level in a signal analyzer, dynamic range or dynamic accuracy in a vector network analyzer, and phase noise or adjacent-channel leakage-power ratio in a signal generator. Next, identify the associated accuracy levels and tolerances for each key specification. Whatever level of accuracy you need, and however tight your tolerances may be, the instruments used for calibration must be even better.

Step 3: Define essential records and reports

A record of the actual work performed is an essential part of the calibration process—and your needs will depend on the customers you serve, the regulatory requirements of the countries you (or they) operate in, your in-house quality measures, internal or external audit requirements, and more. Examples include calibration certificates, traceability reports and data reports (i.e., actual measurement data). As an added convenience, all such reports should be available in electronic and hardcopy forms.

In all cases, you'll want reports that include information about the instruments used for performance testing and calibration. Being able to review those instruments and compare their specifications versus your requirements—accuracy, tolerances, etc.—is essential to retaining confidence in the measurements you depend on most.

A final note: The content of calibration documentation varies from one service provider to another: measurement uncertainty, guard-banded acceptance limits, accreditation body symbol, and so on. Getting a consistent level of detail can help ensure confidence in the calibration of your instruments.

Measuring service providers against your needs

When assessing potential providers of calibration services, a general framework for evaluation is a useful complement to your organization-specific roster of instruments, specifications and reports. The major sections of that framework might be accreditation, calibration and documentation.

The following tables are example templates for a vendor-evaluation tool, and each focuses on one of the three sections described above. To facilitate the evaluation process, each checklist includes a variety of relevant questions—open-ended, yes/no or numeric—that will help you assess how a service provider might perform relative to your specific needs.

Table 1. Evaluation questions focused on accreditation

Accreditation	Provider A	Provider B	Why this is important
What is your scope of accreditation? – How many parameters? – Specifically, which parameters and over what ranges?			The scope of accreditation must include all the parameters and ranges required to test your key specifications.
For each included parameter, what is the best measurement uncertainty you can achieve?			The measurement uncertainty for each parameter must be smaller than the specification limits.

Table 2. Evaluation questions focused on calibration capabilities

Calibration	Provider A	Provider B	Why this is important
How many levels of calibration do you provide? – What types of service deliverables and documentation do those levels include? – Do you test every specification for every installed option in an instrument?			You may want or need a higher-level calibration that complies with ISO/IEC 17025 or is audited by an accreditation body.
Do you use procedures and test software from the original equipment manufacturer? – Do you test every specification using all operating configurations, ranges and data points?			Performing a full suite of OEM tests that covers all test points for all specifications provides greater confidence in the measurements your instrument makes.
If an instrument fails any of its performance tests: – Are adjustments and retesting part of your normal process? – What level of adjustments can you provide?			When a provider can't perform the required adjustments, they will ship the instrument to another vendor for "repair," resulting in longer turnaround time and an additional charge.
If an instrument cannot be adjusted and is in need of repair, can you repair in-house or do you send it to the OEM? – If you repair in-house, do you use new parts, refurbished parts or used parts? – If you do repair work in-house, what is your warranty on repairs?			– If the provider sends the instrument to the OEM for repair, you may experience longer turnaround time and higher cost. – Used parts may have been pulled from a used instrument. As a result, the parts may not have been tested by the OEM.

Table 3. Evaluation questions focused on documentation of calibration processes and results

Calibration	Provider A	Provider B	Why this is important
What is in your measurement reports? – How do your reports help me confirm full coverage of performance testing? – Can individual line items be associated with the key specifications my organization depends on?			A detailed report will help you confirm that all parameters and test points for your key specifications will be tested.
What is in your traceability reports? – Are all listed instruments within your scope of accreditation? – Are all measurements traceable to SI units?			This will help you confirm that the required measurement capability is traceable to a national metrology institute, and has been audited by an accreditation body.
Can you provide sample test reports for my key instruments for the service you'll be quoting or recommending?			Comparing key documents will help you assess each provider's ability to ensure confidence in the measurements you depend on.

Putting the process into action

If you haven't done so recently, it might be time to check your roster of key instruments and re-examine the scope of your critical measurements. After that, it will be worthwhile to compare those needs with your current calibration provider's capabilities and calibration reports.

The key test: Are you getting what you need to ensure your organization's ongoing success? As mentioned at the beginning of this paper, it's all about measurements—and the pass/fail decisions—that you expect your test equipment to deliver.

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