Thinking About the Real Cost of Calibration

It's very likely that your product—whether it is a jet engine, a PC motherboard, or a research report—depends on measurements to support the performance and quality it needs to survive in a competitive market. And your measurement tools require calibration.

Sometimes measurements are a direct quantification of the product itself. An end product such as a 5V DC power supply must measure 5 volts[1]. Other measurements are one step removed: the meter that measures the power supply voltage must itself be measured to confirm that it accurately acquires the analog value and interprets it using the agreed definition of a volt[2].

We rely on calibration to ensure that both levels of measurement are accurate. Without calibration performed to the highest standards of quality, measurement errors can propagate throughout an enterprise and even to the end-user's product… and beyond!

The Calibration Stories No One Likes To Hear

A few examples of problems stemming from incorrect or inadequate calibration provide a clear lesson in the importance of making the right calibration choices.

In a recent case in the United States, a police lab was found to be using an improperly calibrated weighing scale to assess evidence for drug prosecutions. Because penalties depend on the amount of illicit substances found in the suspect's possession, at least one case had to be dropped due to the uncertainty caused by the scale's measurements.

A manufacturer of medical equipment had to recall its product to correct a problem related to the calibration of a tool used in forming a part of the device. It was an expensive error with the potential to impact thousands of end-users and damage the company's reputation with both doctors and patients.

Lastly, a manufacturer of telecom equipment used an independent lab for calibration until one of their instruments was returned with an 'In-Tolerance' certificate, but further testing proved the instrument was actually Out of Tolerance. This may have affected the performance of the equipment and could have resulted in losses to the company's customers.

No one wants to be responsible for errors like these. Choosing a calibration provider is a decision that requires an understanding of both business and technical challenges.

Price vs. Cost

This document will examine calibration as a product—a fee-based service sold in an open and competitive market. We will discuss the nature and value of a quality calibration product as it applies to the electronic measurement instruments—oscilloscopes, spectrum analyzers, video measurement sets, etc.—that support your work.

Calibration services for test instruments are available from providers around the world. The price of calibration service, even when comparing the same specific task among several vendors, can vary widely. Calibration services are a classic value proposition in which much more than price alone must be considered. Think about the cost of calibration. What is the cost to your business when a "calibrated" instrument is deemed non-compliant because of the vendor's practices?

[1]For the sake of simplicity, tolerances are not included in this introductory discussion.
[2]Typically through a chain of traceable instruments leading to a standard at a national laboratory.

Asking the Right Questions

Assume you are evaluating two competitors for a calibration contract affecting Tektronix instruments. One is a non-aligned “third-party” provider, while the other is Tektronix. Both feature outwardly similar calibration product offerings in their websites and literature. A difficult decision? Perhaps. But there are some key questions whose answers bring out the differences that really matter:

► Are both providers really doing the same job?

Much has been said about the number of measurements that support a calibration. For example a vendor might claim to perform, say, 100 measurements compared to its competitors’ 50 tests. Common sense implies that more tests are more thorough and therefore better.

This is true to some extent but what’s more important is the right (appropriate) number of tests. The simplistic numbers that appear on a report can be misleading. Conceivably a vendor that reports 100 tests is actually performing fewer meaningful procedures than its competitor with 50 tests.

A Tektronix calibration routine for one of the company’s high-performance digitizing instruments applies 33,000 individual measurements—of which 48 are reported. This is a graphic example of the contrast between the Tektronix approach and that of some third-party providers. A particular Tektronix calibration procedure may call out five measurements to produce one result. Tektronix reports the single result, while another vendor might claim “more is better” and represent each of the five steps as distinct measurements.

No other vendor supports Tektronix products as thoroughly as Tektronix itself. Note that Tektronix installs all necessary software updates as well as safety and security upgrades as part of its calibration procedures.

► Are both doing the calibration work correctly?

Where do the vendors’ calibration procedures come from? The most rigorous procedures are usually those recommended by the manufacturer. However, these procedures are not required by most calibration standards. If the manufacturer’s steps are more costly to perform, some vendors might omit them to enable lower pricing.

In contrast, Tektronix meets or exceeds its own recommended calibration procedures. The vertical attenuator measurement cycle for oscilloscopes is a good example.

Tektronix oscilloscopes switch vertical attenuation ranges in a 1-2-5 sequence. In some models, changing from the 1V range to the 2V range engages a different attenuator. When calibrating applicable products, the Tektronix procedure checks for nonlinearities at 1.01V, just above the switching point—not just the coarse 1V and 2V detents. The 1.01V setting is not accessible from any user control but Tektronix calibration tools are configured to recognize and control it. This reflects not only a thorough knowledge of how the instrument really works but also a commitment to support the best possible accuracy under exacting test conditions.

The real cost of relying on a lower-priced but less stringent procedure is difficult to quantify. An incorrect or incomplete calibration might overlook a function that compromises a measurement essential to your product’s performance. Consequences might range from yield problems to production flaws that necessitate an expensive recall campaign.

▶ **Do both maintain equivalent certifications?**

Most calibration vendors can show documented proof that they are competent and sufficiently equipped to provide the services offered. Certifying bodies demand that. But once again, it is important to look beyond the basic assumptions.

For example, consider "Identification of the calibration equipment used," an entry that some calibration customers and industries require to appear on calibration certificates. Unfortunately there is little guidance as to the way this information can be expressed. Some vendors simply cite an asset tag number from the calibrating device, with no details about the device itself. That information is "on file" and not readily available to the customer. It is the kind of shortcut that saves money for the vendor and enables a lower pricing structure. But the calibrating instrument, though outwardly compliant, may be unsuitable for the job at hand. And the paying customer is one step removed from an "at-a-glance" assurance that high-quality tools have been used.

In contrast, a Tektronix calibration certificate cites specific traceable instruments and their serial numbers on the certificate. This identifies the traceability path for your particular instrument.

The traceability and accountability implicit in a vendor's certification are important not only in practical terms, but also from an administrative and legal standpoint. In a recent instance, an enterprise that had attempted to save money by opting out of a required accredited calibration was prohibited from offering some of its services until traceability was confirmed. In some cases like this, the enterprise might be required to notify its own customers that its past services are non-compliant, which in turn might force those users to notify their customers that a product or service might be out of compliance, and so on. Clearly, one decision based on price alone can have huge cost consequences.

▶ **Do both offer fully-equipped calibration facilities worldwide?**

A comparison of facilities, environments, and equipment is also worthwhile. Tektronix maintains an infrastructure of facilities and tools to calibrate its products worldwide. These include environmentally-controlled labs at sites around the world; dedicated calibration systems, software, and fixturing; and specialized database tools designed for calibration and service processes. Most third-party calibration vendors simply cannot maintain this level of support for all the products they service. Their solution is to adapt general-purpose tools to these applications.

▶ **Do both have deep expertise and experience with the instruments they calibrate?**

Most calibration technicians in independent calibration companies are generalists with technical credentials (degrees or certifications) in their field. This is very cost-effective for the calibration vendor but cannot match the rigorous product-specific training of Tektronix calibration personnel. Tektronix technicians start with the same basic portfolio of degrees and certifications. Then they learn the fine points of their products by working on them in the production area. They have access, when necessary, to product design engineers to resolve difficult problems. And they continually expand their expertise by qualifying on new instruments as products emerge. At some Tektronix service centers, the technician staff boasts an average of 20 years' experience.

► **Are both able to meet their delivery commitments?**

Your measurement tools belong in an engineering lab or production line where they can earn their keep. Every day your valuable instrument is in the calibration vendor's hands is a day that costs you money.

Industry surveys have shown that Tektronix consistently outperforms third-party calibration vendors when both perform the same services on Tektronix' engineering, design, and research instruments. Third-party vendors typically quote a longer turnaround time than Tektronix—two to three times as long in some cases—and often fail to meet even this commitment. Moreover, many third-party providers simply send the instrument to Tektronix for calibration, further extending the downtime.

► **Do both offer clear documentation to substantiate their results?**

The calibration certificate is the most tangible evidence that an instrument has been calibrated. The certificate is frequently offered as proof that the calibrated instrument is not only within factory specifications but also is compliant with industry standards.

But not all calibration certificates represent the same level of quality. There is no uniform calibration certificate template. Specific content is mandated by standards such as ANSI/NCSL Z540-1-1994 (R2002), ISO/IEC/EN 17025 and others, but the certificate certifies only the most basic adherence to these standards. It is important to understand what lies behind the entries on the certificate.

Tektronix complies with the letter and the spirit of these requirements. A Tektronix certificate contains specifics such as the serial numbers for the calibrating instruments[3]. Other data points include environmental conditions, calibration procedure used and more.

Most calibration vendors offer some form of Test Data Report to supplement the calibration certificate. The document provides a detailed accounting of the actual measurements performed, and their readings.

Here again there is no fixed format for the report. Comprehensive reports often extend to 20 pages or more, but a mass of uncollated data can be difficult and time-consuming to interpret. Without some degree of organization and cross-referencing within the Test Data Report, it may be almost impossible to determine whether every function has been properly tested and/or adjusted.

Tektronix offers Test Data Reports (Figure 1) as an option to its calibration packages. Whatever the length of the report, the information is categorized such that each measurement result can be easily associated with a specific function and requirement. Information is formatted for ease of use, speeding interpretation of the supporting data.

Another Tektronix option is accredited calibration. This denotes a process wherein specific technicians are empowered to calibrate certain devices using certain tools and procedures. Some governmental institutions, research entities, and business enterprises require this measure of assurance that their calibration is traceable and its source accountable. Qualifying for accreditation costs money and Tektronix, like other calibration vendors, offers this extended service optionally at extra cost.

However, **a standard calibration at Tektronix follows the same procedure as the accredited calibration, measuring the same test points to the same limits and tolerances**. The level of the documentation is the only difference. Contrast this with a vendor who is unable to qualify for accreditation or may use a reduced set of tests for their accredited calibrations.

[3]For itemized Tektronix calibration certificate entries, go to http://www.tek.com/service/metrology/calibration-certificates.html

Tektronix®

CALIBRATION DATA REPORT

Certificate Number
1020350-1-TDS220-B019238-2

Instrument Type	Serial Number	Calibration Date	Data	Date Issued
TDS220	B019238	05-DEC-2006	Outgoing	08-December-2006

SPECIFICATION TESTED: DC Voltage Measurement Accuracy

Step / Operation	Nominal	Low Limit	Meas. Value	High Limit	Units	Result	%Spec
CH1 5V/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.2580	3.000	%	Pass	-9
CH2 5V/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.4793	3.000	%	Pass	16
CH1 1V/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.2901	3.000	%	Pass	-10
CH2 1V/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.1267	3.000	%	Pass	4
CH1 500mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.0638	3.000	%	Pass	-2
CH2 500mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.3481	3.000	%	Pass	12
CH1 100mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.1926	3.000	%	Pass	-6
CH2 100mV/div ,250us/div, 20MHz BW Limit	0.000	-3.000	-0.5261	3.000	%	Pass	-18
CH1 100mV/div, +350mVDC	0.000	-21.500	0.325	21.500	mV	Pass	2
CH1 100mV/div, -350mVDC	0.000	-21.500	1.673	21.500	mV	Pass	8
CH2 100mV/div, +350mVDC	0.000	-21.500	-1.955	21.500	mV	Pass	-9
CH2 100mV/div, -350mVDC	0.000	-21.500	1.728	21.500	mV	Pass	8
CH1 50mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.3045	3.000	%	Pass	-10
CH2 50mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.6102	3.000	%	Pass	-20
CH1 20mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	-0.1979	3.000	%	Pass	-7
CH2 20mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.0383	3.000	%	Pass	1
CH1 10mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.3063	3.000	%	Pass	10
CH2 10mV/div, 250us/div, 20MHz BW Limit	0.000	-3.000	0.4700	3.000	%	Pass	16
CH1 5mV/div, 250us/div, 20MHz BW Limit	0.000	-4.000	0.5278	4.000	%	Pass	13
CH2 5mV/div, 250us/div, 20MHz BW Limit	0.000	-4.000	-1.2943	4.000	%	Pass	-32
CH1 5V/div, 250us/div	0.000	-3.000	-0.1115	3.000	%	Pass	-4
CH2 5V/div, 250us/div	0.000	-3.000	0.9140	3.000	%	Pass	30
CH1 1V/div, 250us/div	0.000	-3.000	-0.1484	3.000	%	Pass	-5
CH2 1V/div, 250us/div	0.000	-3.000	0.8271	3.000	%	Pass	28
CH1 500mV/div, 250us/div	0.000	-3.000	-0.0502	3.000	%	Pass	-2
CH2 500mV/div, 250us/div	0.000	-3.000	1.0355	3.000	%	Pass	35
CH1 100mV/div, 250us/div	0.000	-3.000	-0.3468	3.000	%	Pass	-12
CH2 100mV/div, 250us/div	0.000	-3.000	-0.5127	3.000	%	Pass	-17
CH1 50mV/div, 250us/div	0.000	-3.000	-0.3877	3.000	%	Pass	-13
CH2 50mV/div, 250us/div	0.000	-3.000	-0.4291	3.000	%	Pass	-14
CH1 20mV/div, 250us/div	0.000	-3.000	-0.2579	3.000	%	Pass	-9
CH2 20mV/div, 250us/div	0.000	-3.000	-0.0766	3.000	%	Pass	-3
CH1 10mV/div, 250us/div	0.000	-3.000	-0.2837	3.000	%	Pass	-9
CH2 10mV/div, 250us/div	0.000	-3.000	0.3647	3.000	%	Pass	12
CH1 5mV/div, 250us/div	0.000	-4.000	2.4712	4.000	%	Pass	62
CH2 5mV/div, 250us/div	0.000	-4.000	-0.0814	4.000	%	Pass	-2
CH1 500mV/div, 100us/div	0.000	-3.000	1.4223	3.000	%	Pass	47
CH2 500mV/div, 100us/div	0.000	-3.000	1.5575	3.000	%	Pass	52

SPECIFICATION TESTED: Analog Bandwidth

Step / Operation	Nominal	Low Limit	Meas. Value	High Limit	Units	Result	%Spec
CH1, 1V/div BW	0.000	-3.000	-1.7121	3.000	dB	Pass	-57
CH1, 500mV/div BW	0.000	-3.000	-1.5890	3.000	dB	Pass	-53
CH1, 200mV/div BW	0.000	-3.000	-1.6995	3.000	dB	Pass	-57
CH1, 100mV/div BW	0.000	-3.000	-1.7770	3.000	dB	Pass	-59
CH1, 50mV/div BW	0.000	-3.000	-1.8138	3.000	dB	Pass	-60
CH1, 20mV/div BW	0.000	-3.000	-1.8564	3.000	dB	Pass	-62
CH1, 10mV/div BW	0.000	-3.000	-1.9619	3.000	dB	Pass	-65
CH2, 1V/div BW	0.000	-3.000	-1.8096	3.000	dB	Pass	-60
CH2, 500mV/div BW	0.000	-3.000	-1.7021	3.000	dB	Pass	-57
CH2, 200mV/div BW	0.000	-3.000	-1.5523	3.000	dB	Pass	-52
CH2, 100mV/div BW	0.000	-3.000	-1.6448	3.000	dB	Pass	-55
CH2, 50mV/div BW	0.000	-3.000	-1.7106	3.000	dB	Pass	-57
CH2, 20mV/div BW	0.000	-3.000	-1.7789	3.000	dB	Pass	-59
CH2, 10mV/div BW	0.000	-3.000	-2.0304	3.000	dB	Pass	-68

SPECIFICATION TESTED: Time Accuracy

Step / Operation	Nominal	Low Limit	Meas. Value	High Limit	Units	Result	%Spec
Clock Accuracy	0.000	-50.000	11.7000	50.000	ppm	Pass	23

▶ **Figure 1.** *Tektronix Calibration Data report.*

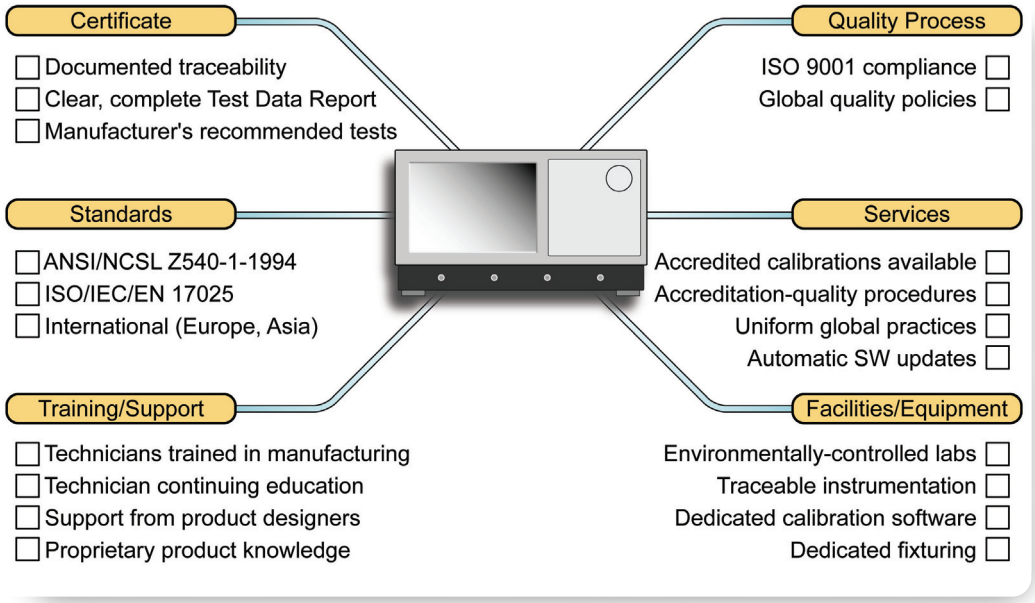
▶ **Do both vendors meet internationally-accepted standards?**

Calibration vendors should comply with either ANSI/NCSL Z540-1-1994 (R2002) in the U.S. or the international standard known as ISO/IEC/EN 17025, or both, in order to compete in their market. Similarly, there are specific national standards in Germany, Japan, Korea, and other regions. Together these standards ensure a reasonable degree of consistency in business and technical practices in the calibration industry.

Compliance with quality management standards, particularly ISO 9001 and its variants, is another level of assurance that many calibration providers offer.

But because most third-party calibration vendors do business only in their own local regions, it is almost impossible to find a trusted provider who can deliver the same level service and expertise at locations around the world. At the same time, the globalization trend is creating a demand for just such services.

Tektronix has calibration facilities in regions around the world. Importantly, all of these institutions are equipped to handle international standards and local/regional requirements. A uniformly-applied ISO 9001 quality management system ensures consistency across all these distributed sites, and in fact, the sites cross-check each others' results periodically to ensure repeatability no matter where an instrument is calibrated. Tektronix performs the same calibration to the same level of quality, irrespective of the location. No third-party vendor can offer this level of service at any price.



▶ **Figure 2.** *Calibration services checklist.*

Conclusion

Choosing a calibration provider for your test instrumentation is a crucial decision in a world where measured picoseconds and nanovolts can make or break a new product. Most vendors offer a similar list of calibration services, and pricing varies widely across the market. But “calibration” is just a word on paper or a browser page. It is important to look at what supports these claims, to ask for the details about the procedures, the facilities, and the skill sets that will go into calibrating your valuable instrument. The checklist in Figure 2 summarizes some guidelines. Look at a sample test data report. Ask about traceability and quality management. Take a tour of the lab where the work will be done. And always remember that price isn’t the same thing as cost.

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