Keysight Technologies
Setting and Adjusting Instrument Calibration Intervals

Application Note

Introduction

For every organization that relies on electronic test equipment, the cost of instrument calibration is sometimes viewed as an expense that could be easily reduced. Calibration costs—and therefore calibration intervals—are part of a broader discussion that includes tradeoffs between risk and cost, and between quality and customer satisfaction.

Because the instrument manufacturer provides a recommended calibration interval, there may be a feeling that this is an arbitrary time span driven by tradition or other motivations. From Keysight Technologies perspective, a well-defined calibration interval is one that balances the tradeoffs between the cost and inconvenience of the process and the need to keep test instruments performing within their specifications. The right cal interval also reduces the risks that come with inaccurate measurements and erroneous pass/fail decisions. Ultimately, our overarching goal is to boost your confidence in two areas: in the results our instruments produce and in the decisions you make based on those results.

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Outlining our approach

Keysight Technologies, Inc. uses well-defined processes to set the initial calibration interval and then assess the possibility of extending that interval. Below, we outline the method used prior to the introduction of a new product and also describe the process we use after a full two years of calibration data is available for a specific model.

This information will be of interest to at least two distinct groups. One is any organization that uses outside service providers and wants to reduce costs without adversely affecting product quality or system performance. The other is self-maintainers seeking guidance regarding internal management of calibration intervals for their instrument pool. Both groups will find answers in the pages that follow.

Setting the initial calibration interval

Prior to the introduction of a new product, the responsible R&D and quality engineers set the initial recommended calibration interval. They do this by looking at reliability data from at least three areas:

- Data from similar products
- Data for the individual components used in the instrument
- Data about any subassemblies leveraged from existing mature products

They also consider the typical operating conditions and the results of the environmental testing performed on product prototypes.

Innovative product design also plays a part. In recent years an increasing number of Keysight instruments have incorporated built-in circuitry and firmware that monitors the instrument state and self-adjusts to maintain maximum accuracy within the limits of the self-adjustment range.

In the past, most manufacturers specified a 12-month calibration interval. Today, 12 months is still Keysight's most common recommended interval; however, an increasing percentage of our instruments have intervals of 24 or 36 months (*Table 1*). This is one key benefit of the next-generation product designs described above. As the recommended cal interval increases, maintenance costs will decline.

Table 1.

From March 2010 to April 2012, an increasing percentage of Keysight products had 24- or and 36-month calibration intervals

Cal interval (in months)	Percent change in number of Keysight products
12	5%
24	6%
36	9%

Adjusting the calibration interval

In response to customers seeking to reduce instrument cost-of-ownership, we have developed a formal "calibration interval extension" process. The process has two major steps: checking for data sufficiency and, if enough data is available, performing detailed statistical analyses. Let's take a closer look at each step [1].

Part 1: Assessing data sufficiency

For a specific model, the process begins with a calibration-interval analysis. The first hurdle: At least two years' worth of calibration history must exist for the model under review. This is the minimum amount of data necessary to reasonably predict how the instrument will behave with an extended calibration period. If less than two years of data is available, then an extension is not possible and the process is suspended; the process may be resumed when sufficient data is available.

The necessary historical data comes from our central calibration monitoring database. This resource captures and stores data from instruments that are checked using the calibration software installed in all Keysight service centers around the world.

The more data we have, the better. After two years, a typical instrument on a 12-month cycle should have two calibration events in the database. With a sufficient number of calibrations on-hand, we can see how much an individual unit has drifted over time. This information is needed to determine an out-of-tolerance rate for each unit within the model-number population.

The last step is to determine the number of days since the last adjustment for each individual serial number within the population. This reveals the length of time before the instrument went out of spec, needed adjustment, or required a repair. It also is the key factor in determining if an interval extension is possible. Secondary factors include the specific sections of the instrument that failed and the judgment of the instrument designers who best understand how each section works and its impact on overall instrument performance.

1. *The same process is used in those rare instances when we need to shorten the recommended calibration interval for a specific model.*

Part 2: Performing the statistical analyses

If the model under review passes the data-sufficiency tests, then the statistical analyses can proceed. The specific methodology depends on three things: the type of instrument, the length of the existing calibration interval and the sample size. Commonly used methods include binary logistic regression, hypothesis testing on proportions, and data fitting to standard reliability distributions.

In most cases, the analysis is a process of curve fitting the in-hand data and obtaining a model that predicts the likely future behavior of the model. This reinforces the importance of sample size: The likelihood of extending the calibration interval increases when we have more instruments on record with a longer number of days before adjustments were required.

All the information highlighted above in the "data sufficiency" section is used in a regression analysis. If the associated standard deviations are reasonable, then the regression provides the slope and constant needed to produce a graph of failure probability information.

Figure 1 is an example of a potential failure-rate graph. It shows a failure rate of approximately four percent at 12 months and six percent at 24 months. These are respectable values for most applications and the example product would warrant consideration for an interval extension.

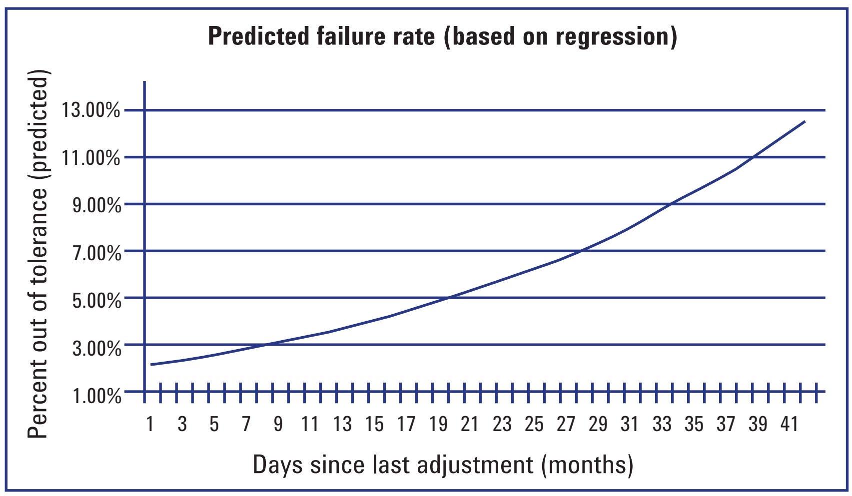

Figure 1. Example of predicted failure rate versus time based on regression analysis of pass/fail data.

In contrast, a failure rate of greater than 10 percent is usually too high for Keysight to consider an extension; however, the final judgment rests with the division engineers who are most familiar with the product and the needs of its customers. In a typical case the engineers would consider additional data such as the specific parts of the instrument that failed, which test points failed (from actual calibration data), and the impact of each failed part or test point on instrument performance.

Using that information, the division team must decide if an extension is acceptable with a failure rate that is higher than usual. Together, Keysight engineers and statisticians are jointly responsible for ensuring that the instrument population will achieve its target level of reliability over the revised calibration interval.

Dealing with reality

As a practical matter, the pressure to reduce costs may be irresistible. In such cases, we suggest a careful prioritization of which instruments to calibrate at the recommended interval and which to calibrate less often.

As a starting point, it is useful to determine which instruments perform tests that are most critical to the ongoing verification of performance in your products. We suggest that these key instruments be calibrated more often. Any other instruments that are less critical to the quality of your end product are the best candidates for an extended calibration period.

Notes for self-maintainers

You can use the process described above as a model for your own internal assessment of extended calibration intervals. As noted earlier, the key to success is having a sufficient amount of calibration data available for all individual units of a specific model. A separate statistical analysis should be performed for each model under consideration.

As above, a chart of the predicted failure rate will help you determine if an extension is warranted. Your internal expectations for metrics such as instrument availability or system uptime will help you determine an internally acceptable failure rate for each model.

Conclusion

Whether we're reviewing a product at introduction or at least two years later, decisions about the calibration interval require a combination of quantitative and qualitative inputs. Our process depends on collecting enough numerical data to provide a quantitative foundation, and we incorporate engineering judgment to add an awareness of real-world risks as they relate to your organization. Taking a broad view, it is important to consider the tradeoffs between cost and quality, between quality and customer satisfaction, and between customer satisfaction and company reputation.

We accept this as part of our big-picture responsibility to you—and we take it seriously. Through ongoing innovations in our products and processes, we're working to address your business needs and today's economic realities.

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