# Practical Steps on Design Verification Using DAQ Data Logger

## What is Design Verification?

During the course of any product development life cycle, product designers must go through a rigorous and disciplined design process control. This process requires design verifications. Often, the design verification process can be single, iterative, or numerous combinations of test recipes. Design verification checks your design inputs incorporated into your product and determines whether they are producing the design outputs that reflect the defined inputs correctly. What does that mean?

Design verification examples:

- You design the product to withstand electrostatic discharge (ESD) of 10,000 Volts. The design inputs may add ESD suppressors and I/O protection circuits. The design verification will induce the high voltage and determine if the product can withstand it.
- The design is for the product to operate at 55 °C; the design inputs are either thermal fins, an exhaust fan, and perhaps more efficient electronic components. The design verification may be to monitor hotspots of the product at very high temperatures while your product operates at maximum capacity.

The DAQ970A Data Acquisition system has high quality switching and advanced 6 ½ digit DMM built-in that allows you to:

- Make auto calibration to compensate for internal drifts over time and temperature changes.
- Reduce thermal voltage offset errors with built-in internal module calibration.
- Measure accurately very low current ranges (1 µA DC current and 100 µA AC current); and higher resistance range (1000 MΩ range).

Learn more by downloading the DAQ970A Data Sheet, 5992-3168EN.

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# Types of design verification activities during product development

The product development life cycle has a few key stages. Throughout the stages, engineers or product designers go through design verification activities to ensure product development is according to plan or the objective.

Most product development activities require some form of test and measurement. You may monitor physical characteristics such as temperature, humidity, pressure, vibration, and more. You may also observe electrical characteristics such as voltage, current, resistance, and capacitance along with tracking a combination of physical and electrical characteristics at the same time.

Figure 1 shows the design verification activities at various stages of the product development life cycle. At the concept stage, you are working on concepts of a potential product. The design verification output may appear on paper and simulation via computer-aided design (CAD). At the investigation stage, you will have various electronic breadboard functional block designs and soft-print mechanical parts, and critical components for evaluation. At this stage, you will need to make basic power-on testing on the functional block designs, troubleshoot designs, and test if the design meets your objectives. You may be evaluating a few designs and several vital components. All these require very versatile test instruments; straightforward to configure and capable of measuring many types of signals.

## Development stage

The project manager may plan for two or three turns of lab prototypes depending on budget and complexity of the product. This is the stage where the product is a fully integrated design. The test coverage suddenly increases 10X-50X or more because you are testing fully integrated product prototypes. You will also perform iterative testing to single out poor designs or unreliable components.
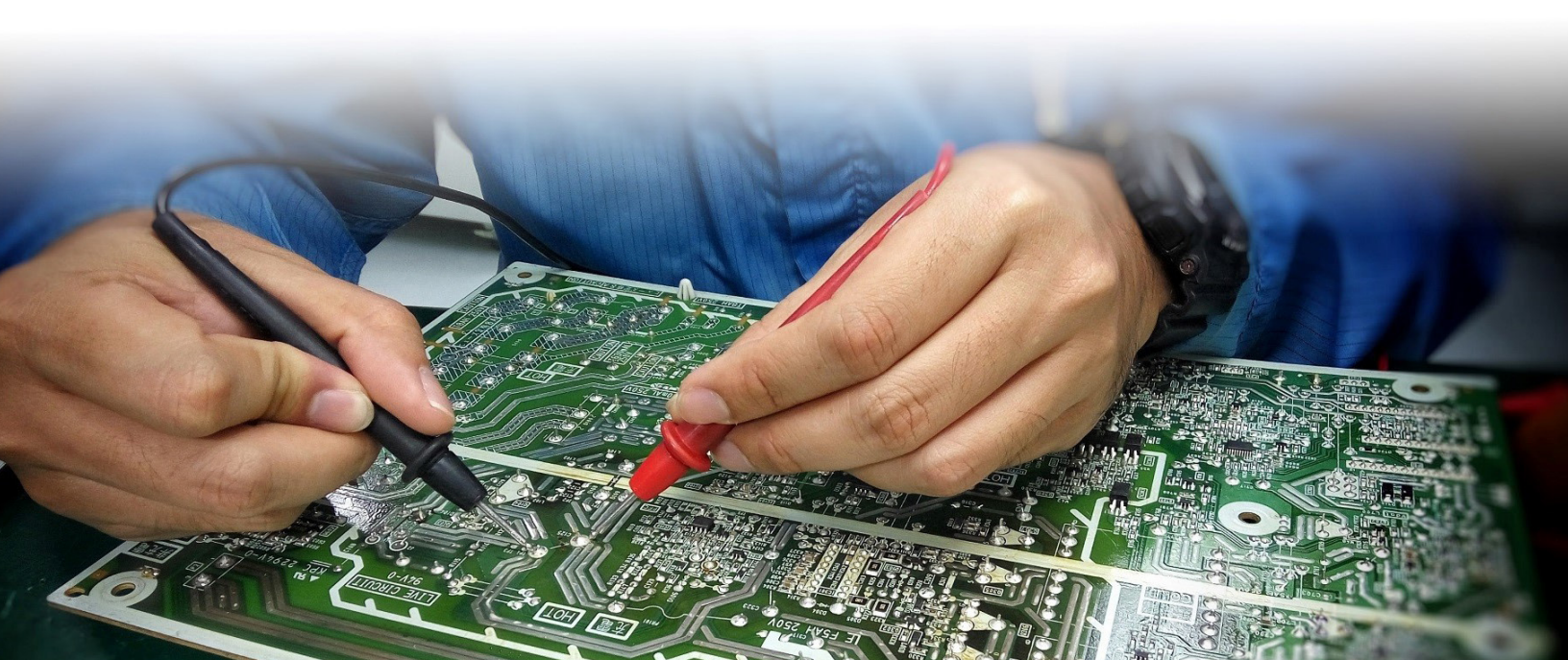
## Qualification and certification stage

A specific sample size of your product will undergo regulatory and safety testing. Depending on the industry, your product must meet specific regulatory and safety compliance requirements. For example, medical devices have to obtain 501k FDA approval in the US. Most general electronic products need to achieve specific environmental test compliance. For example, the IEC 60068, which is a collection of methods for environmental testing of electronic equipment and products. If the products are for military applications, there are military performance specifications that require compliance.
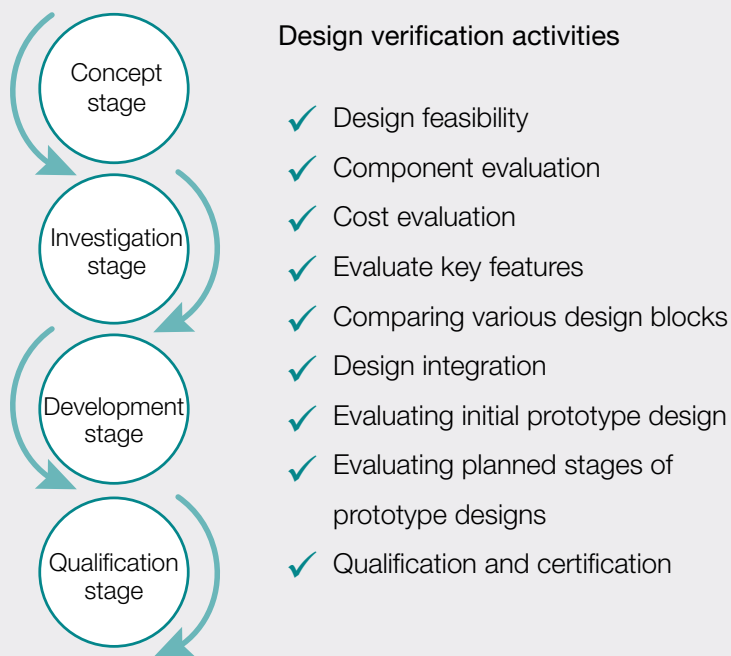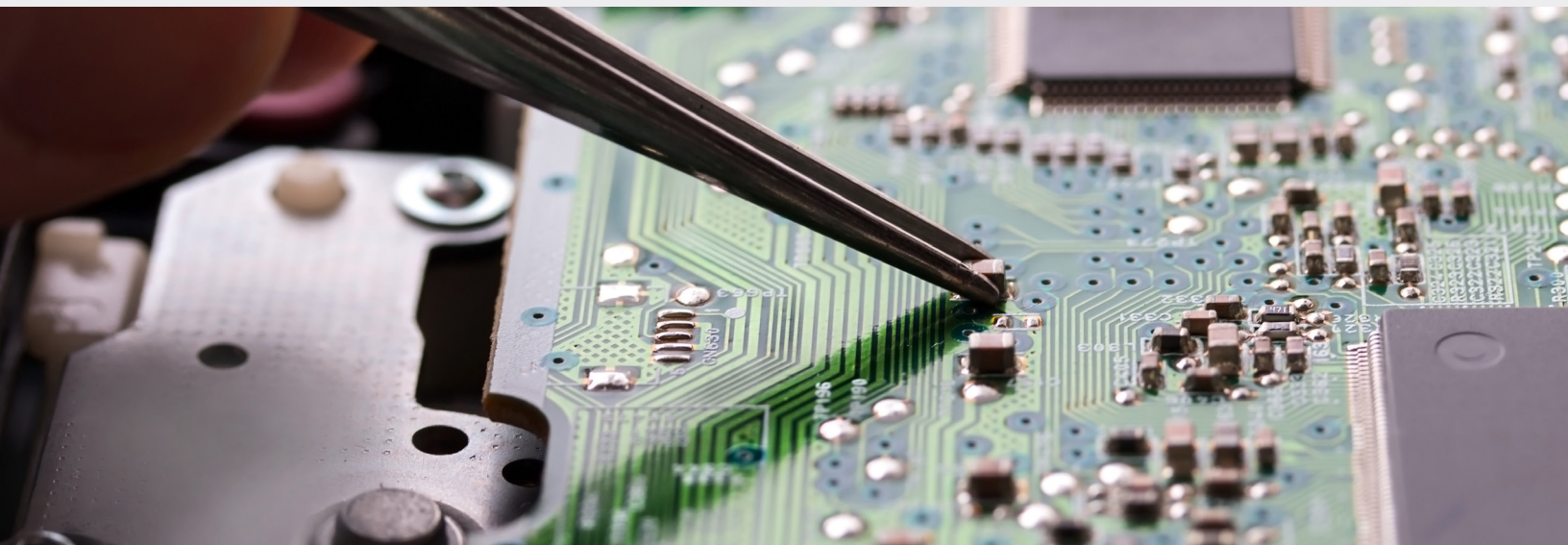
## Product development life-cycle

Concept stage

Investigation stage

Development stage

Qualification stage

**Design verification activities**

✓ Design feasibility

✓ Component evaluation

✓ Cost evaluation

✓ Evaluate key features

✓ Comparing various design blocks

✓ Design integration

✓ Evaluating initial prototype design

✓ Evaluating planned stages of prototype designs

✓ Qualification and certification

**Figure 1. Design verification activities during product development stages**

# Steps using data acquisition (DAQ) data logger for design verification

The design verification process during the development stage is always iterative. The goal for design and test engineers during the design verification process is efficiency and effectiveness. However, the challenge is to not compromise on the test coverage. You want to capture and eliminate all the design problems and constraints upstream during the product development life cycle. Figure 2 shows the four critical areas of testing and how data acquisition (DAQ) can help you improve test efficiency and test effectiveness.
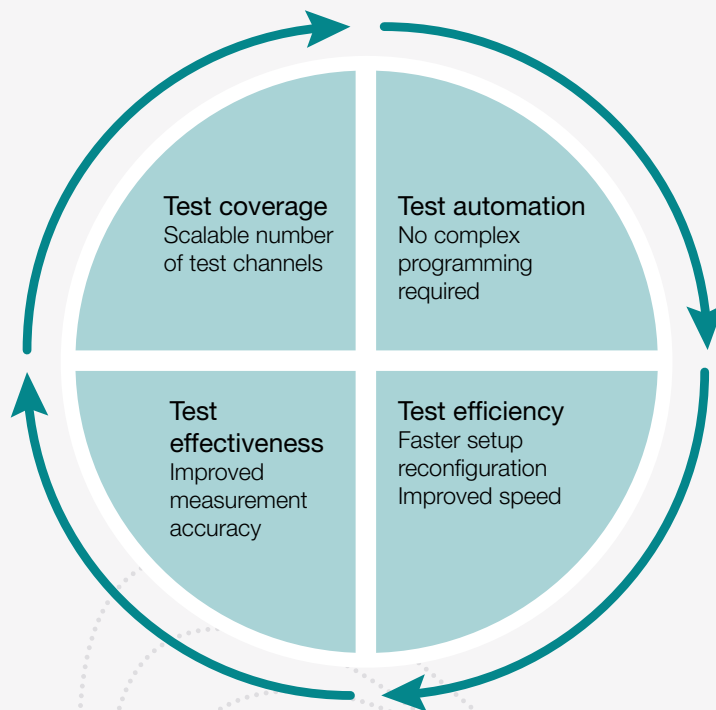
**Test coverage**
Scalable number of test channels

**Test automation**
No complex programming required

**Test effectiveness**
Improved measurement accuracy

**Test efficiency**
Faster setup reconfiguration
Improved speed

**Figure 2. How DAQ data logger can help your testing**

Here are four practical steps that design and development engineers need to follow to ensure proper design verification.

## 1. Plan and organize your test

In any well-organized product design and development organization, there is always a rigorous and disciplined design process control in place. During the development stage, there is an iterative process to find and fix all hardware and software defects. For example, many organizations use the Plan-Do-Check-Act (PDCA) or also known as the Deming cycle.

When you plan your product design, you must also prepare for your verification process.

Make sure the plan is for the long-term than the current test cycle in which you are engaged. For example, you may only need to measure ten temperature points, five voltage points, and two current points. However, when the product goes for full qualification, you may need 40 temperature points, 20 voltage points, and five current points. Bottom line, make sure your test solution is scalable.

Specific DAQ systems allows you to scale the number of test channels. You can add interface modules to increase the test channels. Make sure your test equipment has more than enough test coverage points for the overall project requirements.

Some DAQ systems also have built-in signal conditioning circuitry to either filter out unwanted signals, amplify small signals, attenuate large signals, or linearize signals according to user needs. This signal conditioning helps make measurements attainable and more accurate. Signal conditioning can in many cases improve the dynamic range of your measurements. This is important when considering purchasing new test equipment.



**Figure 3. Keysight's DAQ970A mainframe system with various interface modules.**

## 2. Setup and configure your test

Setting up your test can sometimes be tedious and slow. Imagine you have to wire up to 100 test points. Aside from wiring, you must configure each wire test point in your test system. You need to ensure you select the correct sensor type, measurement range and resolution, scaling such as gain, and offset and pass/fail limits. If each test point takes 1 minute to configure, it will take 1 hour 40 minutes to complete the whole setup.

Newer DAQ systems allows you to copy and paste configuration on your front panel. Better still, there is software such as Keysight's BenchVue DAQ application software that allows you to mouse select and click all your configurations intuitively. It will reduce your configuration time by 4X or more.



| Channel | | | Measurement | | | | Scaling (Mx + B) | | | | | | Alarm Limits | | | |
|---------|--------|------|-------------|-------|-----|------|-------|----------|------------|-------|------|-----|----------|-----|------|------|
| Scan | Number | Name | Function | Range | Res | More | Scale | Gain (M) | Offset (B) | Units | Test | Low | High | HW Alarm | More |
| ⊙ | 34901A:20-Channel Armature Multiplexer | | | | | | | | | | | | | | |
| ☑ | 101 | | Temp (Type J) ▼ | None | C | ▼ ... | ☐ | 1 | 0 | C | Off ▼ | 0 | 0 | Alarm 1 | ... |
| ☑ | 102 | | DC Voltage ▼ | +/- 10 V | 5.5 | ▼ ... | ☐ | 1 | 0 | Vdc | Off ▼ | 0 | 0 | Alarm 1 | ... |
| ☐ | 103 | | DC Voltage ▼ | Auto | 5.5 | ▼ ... | ☐ | 1 | 0 | Vdc | Off ▼ | 0 | 0 | Alarm 1 | ... |
| ☐ | 104 | | DC Voltage ▼ | Auto | 5.5 | ▼ ... | ☐ | 1 | 0 | Vdc | Off ▼ | 0 | 0 | Alarm 1 | ... |
| ☐ | 105 | | DC Voltage ▼ | Auto | 5.5 | ▼ ... | ☐ | 1 | 0 | Vdc | Off ▼ | 0 | 0 | Alarm 1 | ... |
| ☐ | 106 | | DC Voltage ▼ | Auto | 5.5 | ▼ ... | ☐ | 1 | 0 | Vdc | Off ▼ | 0 | 0 | Alarm 1 | ... |

**Figure 4. Keysight's BenchVue DAQ application software, the configuration panel**

You can save your configuration in a file and recall at a later date. You can also modify the file and save the updated configuration. Overall, you become more efficient during the test setup phase.

## 3. Automate and record your test

As a product design/development engineer, you want to test your product rigorously and ensure it passes the qualification test at the final development stage. Hardware or software bugs are often intermittent, or they occur only during specific combinations of test conditions. Therefore, to manually test all the various test conditions is not practical. You may need to automate your testing to run on multiple and variable conditions. Sometimes, it takes hours or overnight tests to verify or characterize a design function fully. Frequently, this process is iterative until your design objective is achieved.

Even in the design and development stages where design verification takes place, it makes good sense to implement test automation.

You can automate, monitor, and record all your tests remotely on a PC. Figures 5 and 6 shows you Keysight's BenchVue DAQ application software and BenchVue's Test Flow feature. BenchVue incorporates a test flow window that allows you to graphically drag and drop blocks of instrument commands, create test loops, decision logic, math functions, and more.



Figure 5. BenchVue's DAQ application software on PC performing data logging, monitoring (trend chart), and recording data on a real-time basis
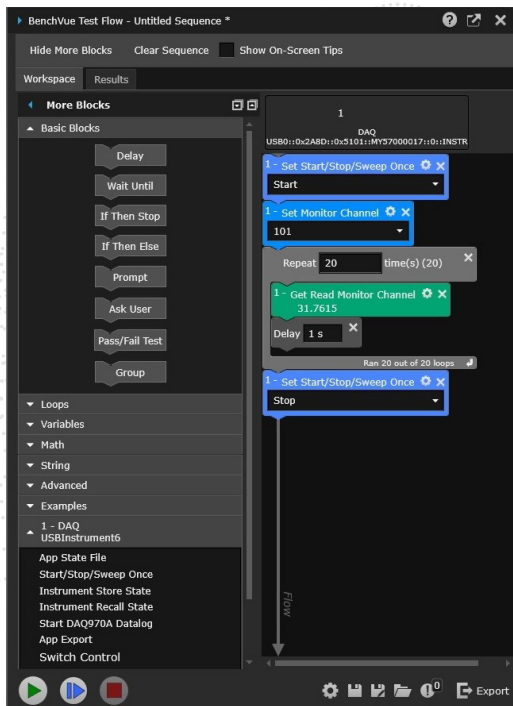


Figure 6. BenchVue's Test Flow feature allows you to automate your test easily without complicated programming

# 4. Post-analysis and report generation

One of the most time-consuming work during design verification is the post analysis and report generation. You will need to convert the recorded raw measurement data into the correct format so that it is readable by Excel or MATLAB. During the post-analysis review, you have to make sense out of the data by running math filters, algorithms to linearize or correct the raw data, and then draw the data on graphical charts using various dimensions and formats.

Fortunately, some new DAQ systems have built-in math computation capability to either multiply, divide, add, or minus between two channels as shown in Figure 7. For example, if you measure voltage and current on a device output on two channels, you can configure a third virtual channel to have the voltage and current multiplied. The third channel will provide the power output to a product of voltage and current channels of the device in real-time.
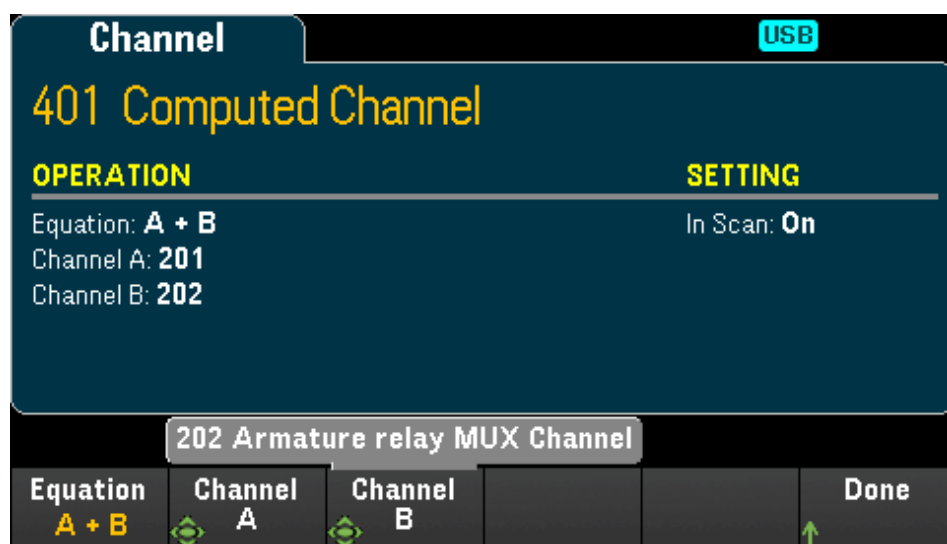


**Figure 7. Example of Keysight's DAQ970A capable of performing computed math between two channels.**

Modern DAQ systems allow you to data log your data directly into a USB thumb drive connected to the DAQ mainframe. Data stored in a standard .CSV format which is easily read by Excel or MATLAB. This allows you to perform post-analysis and report generation easily from the PC.

Keysight's BenchVue DAQ application software runs on the PC and allows you to:

- Plug and play connectivity
- Simple point-and-click and data capturing
- No programming or separate instrument drivers required
- One software platform to integrate your bench instrumentation

- Dedicated apps designed for your instruments
- Quickly build your automated tests in seconds
- Intuitively combine multiple instrument controls

For more information on the software, please visit:

http://www.keysight.com/find/benchvue
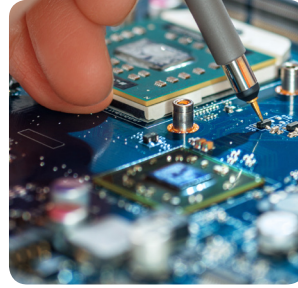
# 5. Other practical steps for test productivity

DAQ systems can do more than scan selected channels and measure point-by-point. It can provide additional intelligence to control your test and even gives you a statistical overview of your measurements. Here are some examples that can help you to improve your test productivity.

## Digital Input / Output and Alarm settings

One of the significant benefits of a DAQ system is that it can provide a closed loop test system. Take for example in Figure 8; you are testing a product's cooling system. You have performed several computer-aided design (CAD) work on airflow simulations, but now you want to do an actual design verification. You put your product inside an oven to test the product from 0 °C to 55 °C. You can wire-up temperature sensors on the critical components to generate temperature profile over time.

Modern DAQ systems have digital I/O to interface with external control systems. It can synchronize testing, trigger, or sequence test steps; or even stop the test in case of emergency. DAQ systems have alarm systems to alert the user if a specific crisis or critical threshold occurs.
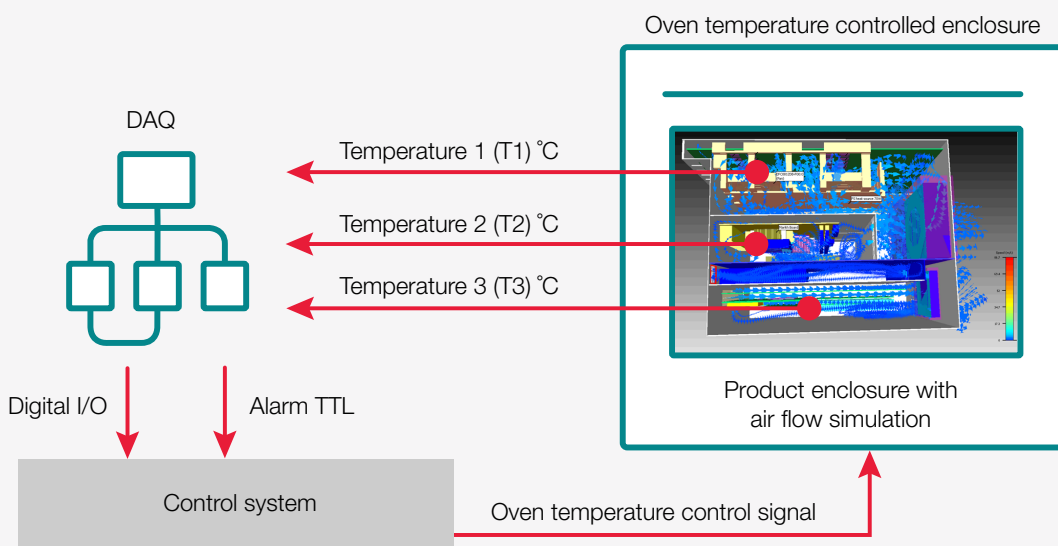


Figure 8. DAQ970A provides Digital Input / Output and Alarm TTL signals

## Monitoring mode

Some DAQ systems have integrated graphical displays on the front panel. Instead of display numbers, the new DAQs can display bar meters, trend charts, and even histograms in real-time while measurements are taken. Numbers on display do not translate into a visual, however, to have a statistical output such as min, max, average, span, and standard deviation gives you some idea whether you have a process or batch issues.
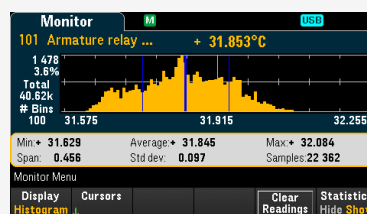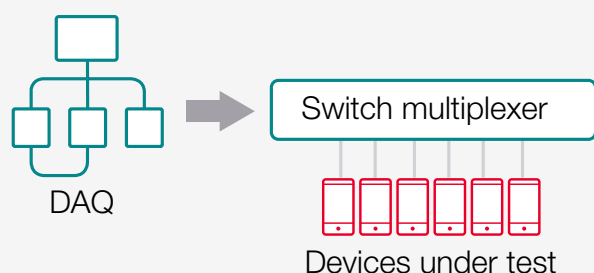


DAQ screen: Monitoring component voltage, capacitance, temperature and more from statistical batch processing quickly help determine process or bad batch issues.

**Figure 9. DAQ970A provides real-time statistical tracking of your measurements**

# Conclusion

Design verification plays a crucial role to check whether the design inputs incorporated into your product produces the design outputs that reflect the defined inputs correctly. There are many kinds of design verification activities throughout the product development life cycle. At the early stages, the focus is on design function feasibility, cost analysis, choosing the right components, and designs. During the development stages, the verification is iterative. The goal is efficiency and effectiveness in your testing.

There are a few key practical steps the DAQ data logger can help you achieve your goals in design verification:

- Plan and organize your testing. When you plan your product design, you must also prepare for the verification process.
- When setting up and configuring your test, you need to ensure you select the correct sensor type, measurement range, and resolution; scaling such as gain and offset, and pass/fail limits.
- Automate and record your tests. Often, this process is iterative until your design objective is achieved. There is PC application software that helps to automate your tests.
- Simplify your post-analysis and report generation work with built-in math computation features in new DAQs and PC application software.
- There are more practical features available in modern DAQs such as digital I/O and alarm capabilities.

To find out more about Keysight's DAQ970A data acquisition mainframe and its interface modules, please visit: www.keysight.com/find/DAQ970A

For more information about Keysight's BenchVue application software, please visit: http://www.keysight.com/find/benchvue
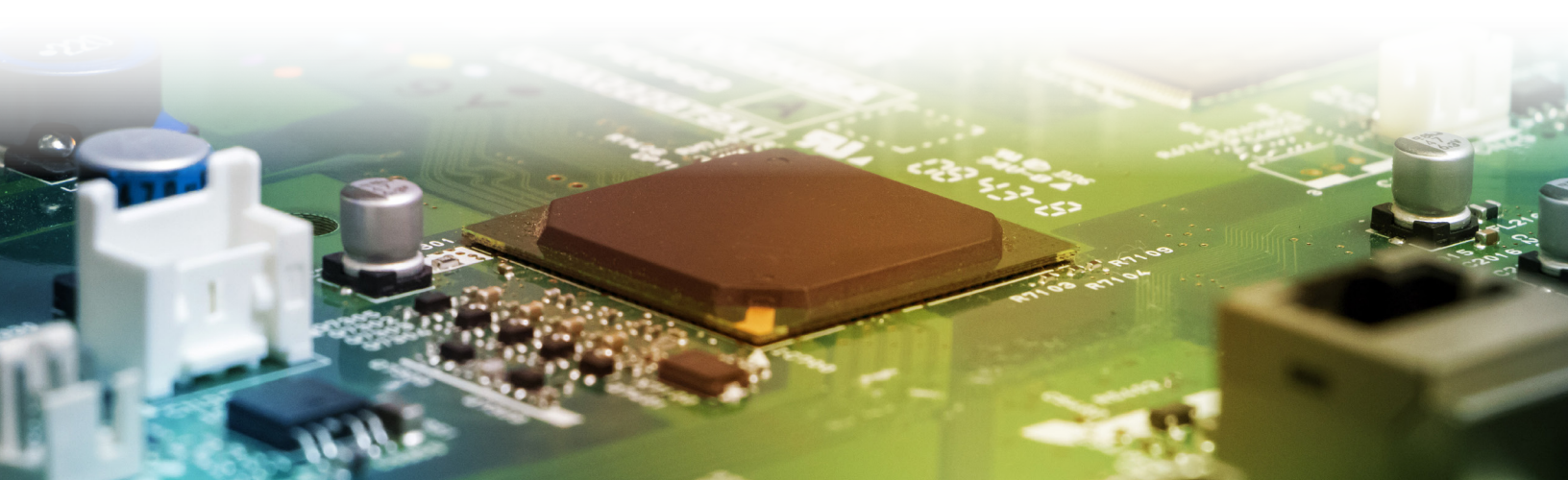
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