Keysight Technologies
Electronic Components Tolerance and Test Limits for In-Circuit Test

Technical Overview

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

Background

Electronic components such as resistors, capacitors and Integrated circuits (ICs) assembled on a printed circuit board (PCB) form a product. In order for the product to work effectively, all assembled components must function correctly. The components are measured and analyzed electrically using an in-circuit tester (ICT) to ensure its values and performance are optimal.

The active and passive components of the PCB are tested on the manufacturing floor with a bed–of-nails fixture. The pass/fail status of the passive components typically determine the reference range of how precise the product meets its ideal values. As such, the two-sided tolerances (upper and lower test limits) like the “goal posts” in a soccer game are set. The measured values need to make it between the “goal posts” consistently during testing for the components to achieve a “pass” rating

Developing Test Code

When components are placed on a PCB, their resistive/capacitive/inductive values are no longer purely dependent on a single component but rather on the multiple parallel circuit paths and circuit topology, which include the IC connected to them. The measured values will depend on the isolation and guarding effectiveness of the system and/or equipment used to perform the measurement.

The component values may influence the system residue, accuracy, resolution, noise ratio, compensation, connectedness of the system to fixture, fixture wiring, test probe to board under test and solder ability on the PCB assemblies.

At Keysight Technologies, Inc., we utilize Monte Carlo methodologies to perform tolerance analysis-based test where the software performs a multi-system simulation of the test path to determine measurement tolerances for optimum throughput, accuracy, and repeatability. This simulation involves modeling the production variations in multiple systems and performing a statistical analysis of measurement path uncertainty. The tolerance limits are then determined from the analyzed simulation to produce tests that usually require minimal debugging.

Integrated Program Generator (IPG) is the software that writes the test code during the test development phase. Several parameters need to be defined, such as tolerance multiplier, diode current and fuse threshold. Some of these parameters will determine the quality of the test.

The Tolerance Multiplier will influence test accuracy. When set to value 10, it translates into faster throughput with less accuracy. When set to 0.1, analog devices analyze and measure closer to their specified tolerance. A value of 0.1 requires more tester resources and the use of test options, which slows down test throughput. Hence, only use the "0.1" setting on an individual component when it requires more precise test accuracy. That will provide faster throughput for most of the components. For example:

```
C51          330u    20    20 f PN"5B-63-0468G";
  OVERRIDE
    Tolerance Multiplier    0.1;
```

Figure 1. Setting the value of the Tolerance Multiplier

In addition to the test information, the fixture such as common lead resistance and inductance can be characterized to improve accuracy. Those parameters will influence the IPG writing of the test code. Use default values if no special test requirement is needed. Use measured values if more accuracy is required.

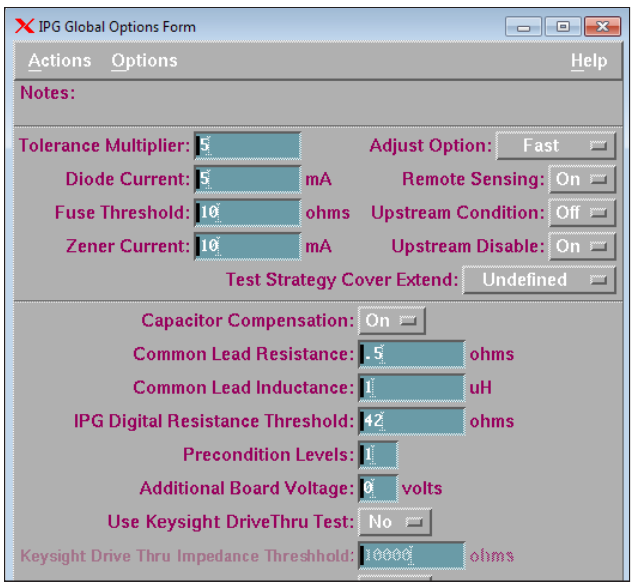

Figure 2. IPG global options default values and settings

Adjusting Test Code

The test engineer will set the desired “goal posts” according to the component tolerance specifications from the Bill of Material (BOM). However, the resistors may vary in power rating, characteristics, and materials. Some of these differences are temperature, frequency, voltage and circuit topology. In addition, there are also other residual parameters that affect of operating conditions such as test methodologies (two-wire or four wire measurements), fixturing, test setup, solder-ability and contact mechanics of the probe to a board-under-test.

So, what should be the best “goal posts” that the test engineer can set? The test goals are set wider than the component ideal tolerance to allow for measurement uncertainty.

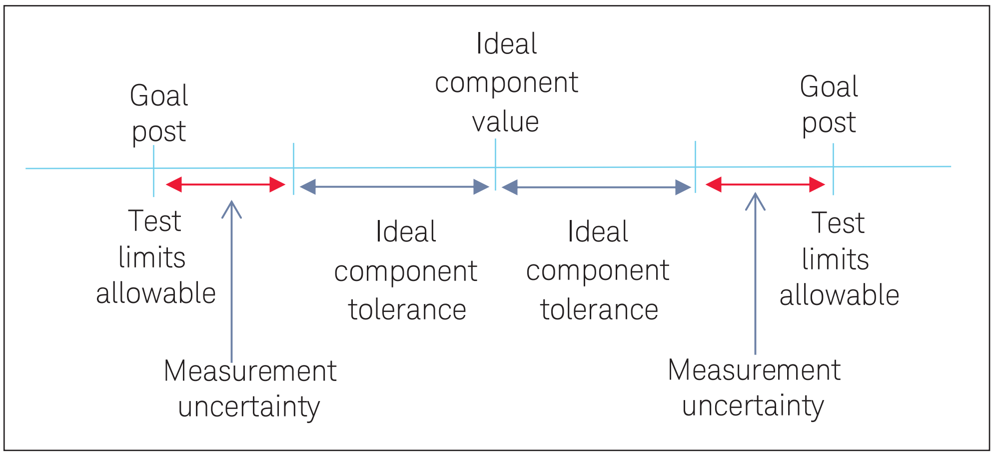

Figure 3. Tolerance and Test Limits

There are no fixed rules to determine the best tolerance settings; however, we recommend that you:

1. Set the desired *goal posts* according to the component tolerance specifications from the Bill of Material (BOM)
2. Perform tolerance analysis-based testing
3. Determine the measurement uncertainty
4. Refer to the product test requirements or guidelines as necessary
5. Consult the schematic diagram and guard as many parallel paths as possible.
6. Use offset rather than adjusting the *goal post(s)*
7. Use quality tools such as Keysight CPK Histogram or Board Grader to do checks and balances on the stability versus First Pass Yield.

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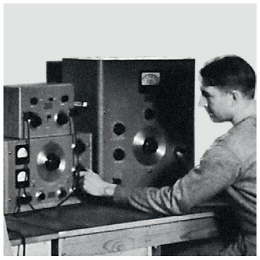

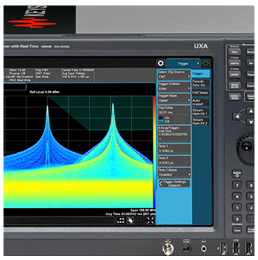

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Published in USA, December 1, 2017
5992-2186EN
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