

Keysight Technologies

Electronic Components Tolerance and Test Limits for In-Circuit Test

Technical Overview



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.

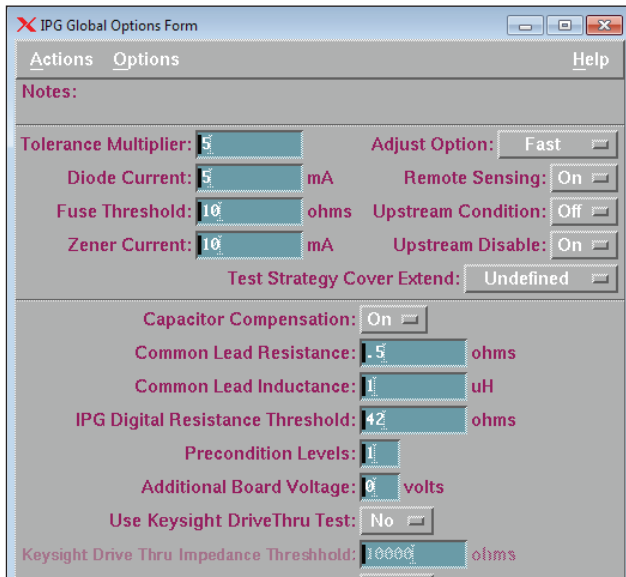


Figure 2. IPG global options default values and settings

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.

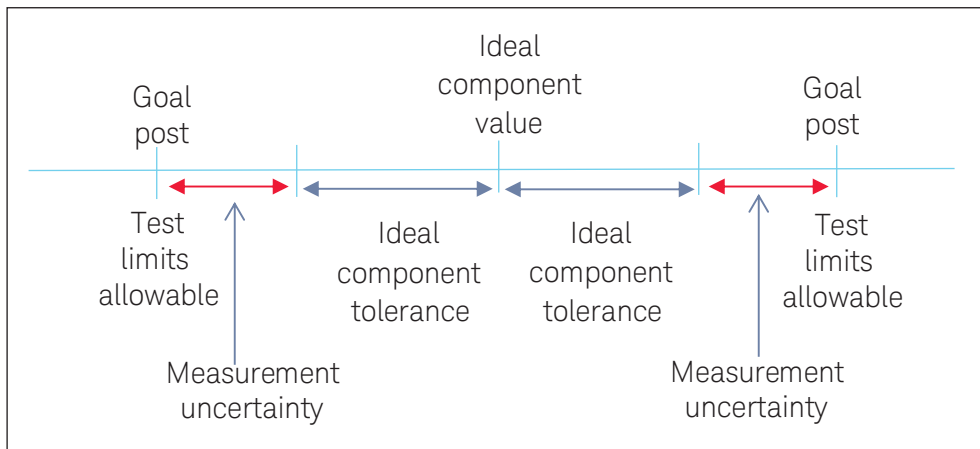


Figure 3. Tolerance and Test Limits

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.

Evolving

Our unique combination of hardware, software, support, and people can help you reach your next breakthrough. **We are unlocking the future of technology.**



From Hewlett-Packard to Agilent to Keysight

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 11 2626
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
 (BP-2-23-17)

DEKRA Certified
 ISO 9001 Quality Management System

www.keysight.com/go/quality
 Keysight Technologies, Inc.
 DEKRA Certified ISO 9001:2015
 Quality Management System

This information is subject to change without notice.
 © Keysight Technologies, 2017
 Published in USA, March 10, 2017
 5992-2186EN
www.keysight.com

myKeysight

myKeysight

www.keysight.com/find/mykeysight

A personalized view into the information most relevant to you.

KEYSIGHT SERVICES

Accelerate Technology Adoption.
 Lower costs.

Keysight Services

www.keysight.com/find/service

Our deep offering in design, test, and measurement services deploys an industry-leading array of people, processes, and tools. The result? We help you implement new technologies and engineer improved processes that lower costs.

Three-Year Warranty

www.keysight.com/find/ThreeYearWarranty

Keysight's committed to superior product quality and lower total cost of ownership. Keysight is the only test and measurement company with three-year warranty standard on all instruments, worldwide. And, we provide a one-year warranty on many accessories, calibration devices, systems and custom products.



Keysight Assurance Plans

www.keysight.com/find/AssurancePlans

Up to ten years of protection and no budgetary surprises to ensure your instruments are operating to specification, so you can rely on accurate measurements.



Keysight Channel Partners

www.keysight.com/find/channelpartners

Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/ict