



IPC-9151D

2012 - May

Process Capability, Quality, and Relative Reliability (PCQR²) Benchmark Test Standard and Database

Supersedes IPC-9151C
May 2010

A standard developed by IPC

Association Connecting Electronics Industries



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IPC-9151D

Printed Board Process Capability, Quality, and Relative Reliability (PCQR²) Benchmark Test Standard and Database

Developed by the PCQR² Subcommittee (D-36) of the Rigid Printed Board Committee (D-30) of IPC

Supersedes:

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Users of this publication are encouraged to participate in the development of future revisions.

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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the IPC PCQR² Subcommittee (D-36) of the Rigid Printed Board Committee (D-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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Process Capability, Quality, and Relative Reliability (PCQR²) Benchmark Test Standard and Database

1 SCOPE

1.1 Purpose The purpose of this document is to define the Process Capability, Quality, and Relative Reliability (PCQR²) Benchmark Test Standard and Database Program used for the evaluation of printed board manufacturing processes. This is in accordance with *The National Technology Roadmap for Electronic Interconnections 2000/2001* published by IPC, which states that “For a company to efficiently manage its supply chain it must identify the capability of its suppliers and make certain that their capability for manufacturing a product is consistent with the needs of the customer.”

1.2 Documentation Hierarchy All other IPC documents take precedence over this document. This document was developed by the IPC D-36 Subcommittee of the Rigid Printed Board Committee (D-30) of IPC, and describes the process to evaluate the manufacturing process capability of printed board fabricators for certain key features.

1.3 Definition of Terms The definition of all terms used herein **shall** be as specified in IPC-T-50 and as defined below.

Analysis Report Detailed statistical data on each fabricator’s database submission.

Comparison Report Comparative statistical data of each fabricator participating in the database.

Conductor Analysis Technologies, Inc. (CAT) The company providing and controlling the intellectual property associated with the process capability panel designs, test methods, data analysis techniques, and the database.

Database Submission A set of process capability panels submitted by a fabricator for testing, data analysis, and inclusion in the database.

Database Subscriber A company or an organization, or division(s) thereof, associated with the electronics industry that obtains access to the database through an annual subscription from IPC.

Database Supplier A fabricator who submits a set of process capability panels for testing, data analysis, and inclusion in the database.

Design Requirements File The file used to detail the specifications and manufacturing requirements of each process capability panel design.

Design Library The family of process capability panel designs developed by the IPC D-36 Subcommittee.

Fabricator A specific company’s or organization’s facility that manufactures printed boards.

PCQR² Database The electronic storage medium for the data and reports generated from the testing of process capability panels.

Peer Report Comparative data showing participating fabricator performance with respect to peers.

Process Capability Data The data generated from the testing of process capability panels.

Process Capability Panel A parametric test panel that is comprised of test modules designed to evaluate specific features of printed boards.

Submission Form The information provided by fabricators upon submitting a set of process capability panels to the database.

Subscription License Agreement The method used by subscribers to gain access to the database which is available at www.pcbquality.com.

Test Module The individual element of a process capability panel.

1.4 Applicable Documents The following specifications of the revision in effect at the time of order form a part of this document to the extent specified herein.

IPC-TM-650 Test Methods Manual¹

2.6.27 Thermal Stress, Convection Reflow Assembly Simulation

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

2 PROCESS SUMMARY

2.1 Introduction Many printed board users have developed internal processes to evaluate the capabilities of their printed board fabricators. As a result, fabricators often receive requests from multiple customers to manufacture test panels as part of qualification procedures. The PCQR² database program provides an industry standard for the design of these test panels. The resulting data provides subscribers with the ability to review detailed results from individual fabricators, to compare the capabilities of multiple fabricators, and to eliminate multiple or redundant requests to fabricators.

2.2 Process Steps

1. At the request of a database subscriber(s) or on their own behalf, fabricators **shall** download the appropriate process capability panel designs, associated requirements files, and submission forms from the design library at www.pcbquality.com.
2. The fabricator manufactures the process capability panels using their standard processes per the specifications and requirements outlined in the design requirements file and AABUS.
3. The fabricator completes the submission form as instructed in the requirements file, and ships all panels at one time. Testing will not begin until all panels and the submission form have been received.
4. CAT or a third party facility licensed by IPC performs the required testing of the process capability panels. All data analysis and report generation **shall** be performed by CAT.
5. Reports and summary information are posted to the database at www.pcbquality.com.
6. Current subscribers are informed of the posting and of the fabricator's identity within the database.
7. The fabricator is provided with a copy of their analysis report and an applicable "peer report" for their submission.
8. The process capability panels are not the property of CAT or IPC, and if requested will be returned to the owner when the testing and data analysis has been completed. The panels will be stored for a period of two months from the posting of the data, after which time CAT may dispose of the panels. Unclaimed panels may be used by CAT and/or IPC for other committee-approved activities.

3 PROCESS CAPABILITY PANEL DESIGNS

3.1 Design Library The PCQR² process capability panel designs are provided under license to IPC by CAT for use by its members and the printed board community. The designs are to be used exclusively for the support of the PCQR² database and related activities. The most current process capability panel designs are posted at www.pcbquality.com.

3.2 Panel Layouts The process capability panels consist of an array of 25.4 x 25.4 mm [1.0 x 1.0 in] test modules, several test coupons within this array, and a 25.4 mm [1.0 in] border that includes nomenclature and alignment features. An individual design layout map is included in each set of design files posted at www.pcbquality.com. The test modules and coupon types include conductor/space, via registration, via formation, via reliability, solder mask registration, controlled impedance, conductive anodic filament and cross-section.

3.3 Test Modules and Coupons The test modules/coupons are designed to allow evaluation of detailed information on a range of feature types and sizes. Table 3-1 details the information that is obtained from each of the modules/coupons.

3.4 Manufacturing Requirements Each of the designs has an accompanying requirements file that describes its specific features and manufacturing requirements.

1. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/html/testmethods.htm)

Table 3-1 Test Module Statistical Attributes

Module/Coupon	Capability	Quality	Reliability
Conductor/Space	Conductor and space yield	Conductor width and height control	–
Via Registration	Probability of breakout		–
Via Formation	Via yield	Resistance control	
Via Reliability			Cycles to failure
Solder Mask Registration	Probability of encroachment		–
Controlled Impedance	Impedance control		–
Conductive Anodic Filament	–	–	Time to failure

4 TEST AND ANALYSIS

4.1 Testing and Data Analysis The panels **shall** be tested by CAT or by a third-party licensed by CAT and approved by the IPC D-36 Subcommittee. All data analysis, report generation, and posting to the database **shall** be performed by CAT. The type of measurement performed on each module is detailed in Table 4-1.

Table 4-1 Measurements

Module/Coupon	Measurement Type
Conductor/Space	Precision resistance
Via Registration	Resistance
Via Formation	Precision resistance
Via Reliability	Precision resistance
Solder mask Registration	Resistance
Controlled Impedance	Time Domain Reflectometry (TDR)
Conductive Anodic Filament	Voltage

4.2 Via Reliability and Conductive Anodic Filament Testing

4.2.1 Assembly Simulation After initial capability and quality testing, representative reliability and conductive anodic filament coupons **shall** be subjected to six cycles of a convection solder reflow profile. The conditioning and reflow profiles **shall** be in accordance with IPC-TM-650, Method 2.6.27. The reflow profile used will be AABUS.

4.2.2 Via Reliability Testing The via reliability coupons that are subjected to the assembly simulation process **shall** be thermal-cycled using the Highly Accelerated Thermal Shock (HATS) reliability test methodology, which was developed for the IPC-PCQR² program. The temperature extremes and the number of cycles are detailed in Table 4-2.

Table 4-2 HATS Cycle

Lower Temperature	Upper Temperature	Number of Cycles
-40 °C	+145 °C	500 or until open

4.2.3 Conductive Anodic Filament Testing The conductive anodic filament coupons that are subjected to the assembly simulation process **shall** be subjected to temperature, humidity and bias conditions as detailed in Table 4-3.

Table 4-3 Conductive Anodic Filament Test Conditions

Temperature	Humidity	Bias	Time
75 °C	85% RH	48 volts	500 hours or until failure

5 DATABASE

5.1 Data The data collected from each submission is compiled into the database that details the process capability, quality, and reliability demonstrated by fabricators. The data **shall** remain active for a period of thirty-six months from the posting date after which time it will be removed and archived.

5.2 Database Access Access to the database is provided only through an annual subscription from IPC, and is based on the subscribers' annual electronics revenues. Subscribers are allowed access to all database reports, summary information and fabricator identities during the term of their subscription.

6 UPDATES AND REVISIONS

The design library and database will be reviewed and updated periodically by the IPC D-36 Subcommittee. Additions, deletions, and modifications will be made to the design library and database to reflect the needs of subscribers and fabricators. These revisions must be approved by the active subscribers. In all cases, the most current revisions **shall** be used and are the controlling documents. Requests to support archived designs more than three months old **shall not** be accepted.



ANSI/IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits Definition Submission/Approval Sheet

The purpose of this form is to keep current with terms routinely used in the industry and their definitions. Individuals or companies are invited to comment. Please complete this form and return to:

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Term	Definition

If space not adequate, use reverse side or attach additional sheet(s).

Artwork: Not Applicable Required To be supplied
 Included: Electronic File Name: _____

Document(s) to which this term applies: _____

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President and CEO
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Thank you for your decision to join IPC. Membership is **site specific**, which means that IPC member benefits are available to all individuals employed at the site designated on this application.

To best serve your specific needs, please indicate the most appropriate member category for your facility.
(Check one box only.)

Printed Circuit Board Manufacturer

Facility manufactures and sells printed circuit boards (PCBs) or other electronic interconnection products to other companies. What products do you make for sale? (check all that apply)

- One and two-sided rigid, multilayer printed boards Flexible printed boards Other interconnections
 Printed electronics

Electronics Manufacturing Services (EMS) Company

Facility manufactures printed circuit assemblies, on a contract basis, and may offer other electronic interconnection products for sale.

OEM — Original Equipment Manufacturer

Facility purchases, uses and/or manufactures printed circuit boards or other interconnection products for use in a final product, which we manufacture and sell.

What is your company's primary product line? _____

Industry Supplier

Facility supplies raw materials, equipment or services used in the manufacture or assembly of electronic products.

Which industry segment(s) do you supply? PCB EMS Both Printed electronics

What products do you supply? _____

Government, Academia, Nonprofit

Organization is a government agency, university, college or technical or nonprofit institution which is directly concerned with design, research and utilization of electronic interconnection devices.

Consulting Firm

What services does the firm provide? _____



Application for Site Membership

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Street Address			
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Name of Primary Contact			
Title	Mail Stop		
Phone	Fax	E-mail	

Payment Information (Purchase orders not accepted as a form of payment)

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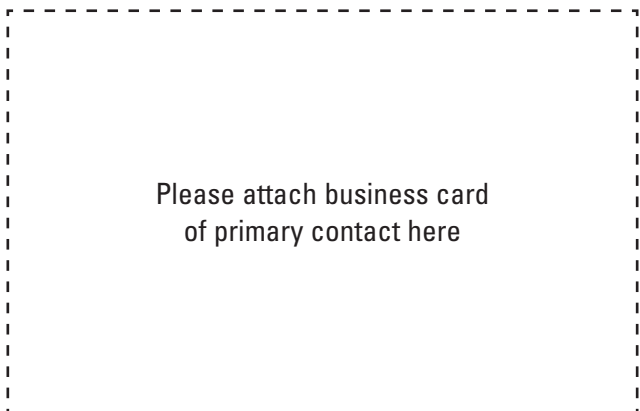
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IPC-9151D

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- Test Method number _____, paragraph number _____

The referenced paragraph number has proven to be:

- Unclear
- Too Rigid
- In Error
- Other _____

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