ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-6011

Generic Performance Specification for Printed Boards

IPC-6011
July 1996
A standard developed by IPC

Supersedes IPC-RB-276

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The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for Engineering (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Increase time-to-market
- Keep people out
- Increase cycle time
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- Contain anything that cannot be defended with data

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Generic Performance Specification for Printed Boards

Developed by the Performance Specifications Task Group (D-33a)
of the Rigid Printed Board Committee of IPC

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

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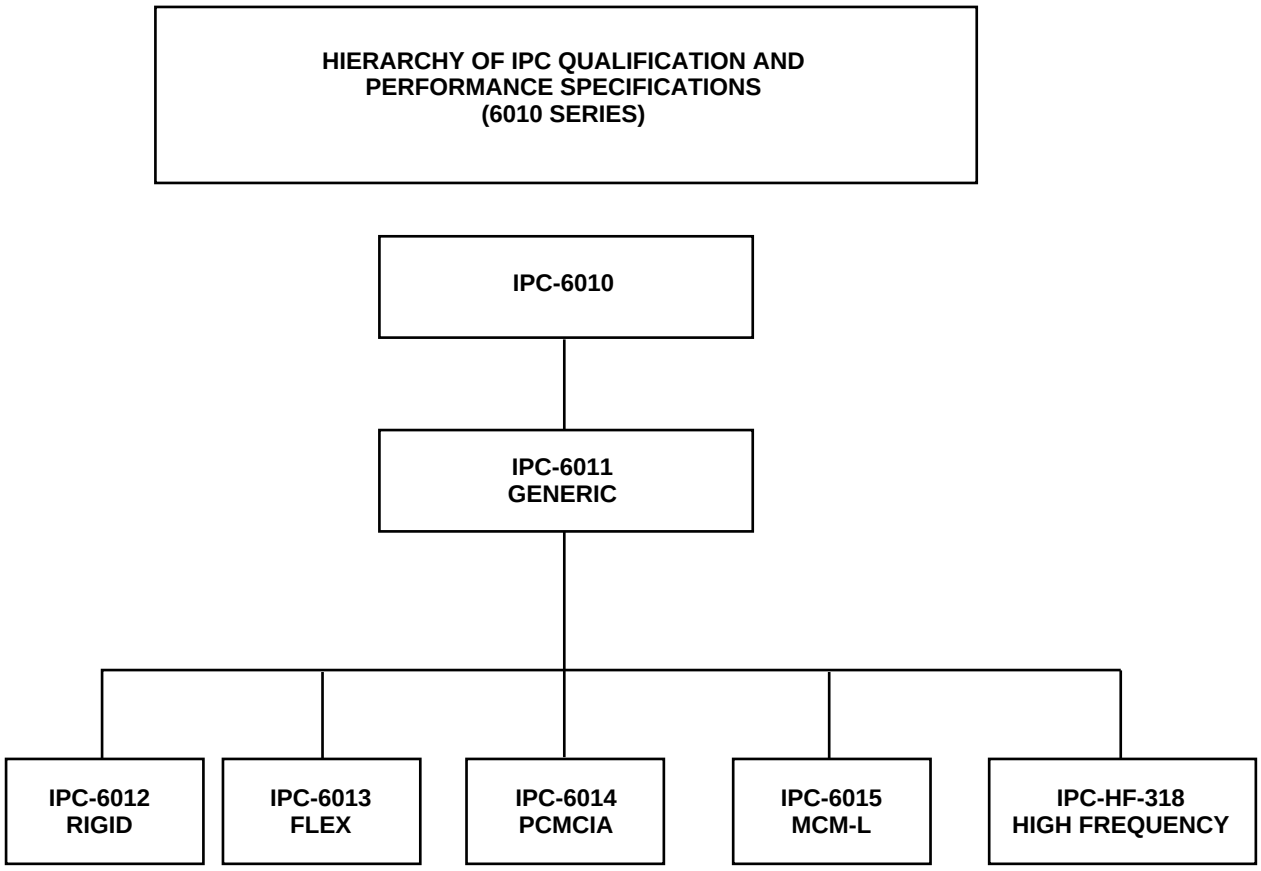

Foreword

IPC's documentation strategy is to provide distinct documents that focus on specific aspects of electronic packaging issues. In this regard document sets are used to provide the total information related to a particular electronic packaging topic. A document set is identified by a four digit number that ends in zero (0) (i.e., IPC-6010).

This standard is intended to provide information on the generic specifications for printed boards. This information must also be supplemented by a performance specification that contains the requirements for the chosen technology. When used together, these documents should lead both manufacturer and customer to consistent terms of acceptability.

This document, combined with one of the performance specifications, form the documentation package which supersedes the following:

IPC-6012 supersedes IPC-RB-276
IPC-6013 supersedes IPC-RF-245 and IPC-FC-250

As technology changes, a performance specification will be updated, or new focus specifications will be added to the document set. The IPC invites input on the effectiveness of the documentation and encourages user response through completion of ''Suggestions for Improvement'' forms at the end of each document.

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Performance Specifications Task Group of the IPC Rigid Printed Board Committee 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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Table of Contents

Tables

Generic Performance Specification for Printed Boards

1.0 SCOPE

1.1 Statement of Scope This specification establishes the general requirements for printed boards and the quality and reliability assurance requirements that must be met for their acquisition. The intent of this specification is to allow the Printed Board user and supplier flexibility to develop optimum procedures for the Manufacture and Procurement of Printed Boards.

1.2 Performance Classes Three general classes have been established to reflect progressive increases in sophistication, functional performance requirements and testing/inspection frequency. It should be recognized that there may be an overlap of equipment categories in different classes. The user has the responsibility to specify in the contract or purchase order the performance class required for each product and **shall** indicate any exceptions to specific parameters, where appropriate.

Class 1 General Electronic Products — Includes consumer products, some computer and computer peripherals suitable for applications where cosmetic imperfections are not important and the major requirement is function of the completed printed board.

Class 2 Dedicated Service Electronic Products — Includes communications equipment, sophisticated business machines, instruments where high performance and extended life is required and for which uninterrupted service is desired but not critical. Certain cosmetic imperfections are allowed.

Class 3 High Reliability Electronic Products — Includes the equipment and products where continued performance or performance on demand is critical. Equipment downtime cannot be tolerated and must function when required such as in life support items or flight control systems. Printed boards in this class are suitable for applications where high levels of assurance are required and service is essential.

1.3 Dimensions and Tolerances All dimensions and tolerances specified herein are applicable only to the end product. Dimensions are expressed in millimeters. Users are cautioned to employ a single system and not intermix metric and inch-based equivalents. Reference information is shown in parentheses ( ).

1.3.1 Acceptability When Limiting Values Are Specified Specified limiting values of 63.5 mm maximum, 63.50 mm maximum, and 63.500 mm maximum are taken to mean that, for the purposes of determining conformance to this specification, an observed value **shall** be rounded off to the nearest 0.1 mm, 0.01 mm, 0.001 mm if metric units are used [to the nearest 0.1 inch, 0.01 inch, 0.001 inch if English units are used], and compared to the specified limiting value. Rounding applies to both maximum and minimum values.

1.3.2 Rounding Convention When a figure is to be rounded to fewer digits than the total number available, the procedure **shall** be as follows:

a) When the first digit discarded is less than 5, the last digit retained should not be changed. For example, 3.4634, if rounded to 4 digits would be 3.463; if rounded to three digits, 3.46.

b) When the first digit discarded is greater than 5, or if it is a 5 followed by at least one digit other than 0, the last digit retained should be increased by one unit. For example 8.37652, if rounded to four digits would be 8.377; if rounded to three digits, 8.38.

c) When the first digit to be discarded is exactly 5, followed only by zeros, the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number. For example, 4.365, when rounded to three digits, becomes 4.36. The number 4.355 would also round to the same value 4.36, if rounded to three digits.

The final rounded figure **shall** be obtained from the most precise value available and not from a series of successive roundings.

1.4 Interpretation "Shall," the emphatic form of the verb, is used throughout this specification whenever a requirement is intended to express a provision that is binding. Deviation from a **"shall"** requirement may be considered if sufficient data is supplied to justify the exception.

The words ''should'' and ''may'' are used whenever it is necessary to express non-mandatory provisions.

''Will'' is used to express a declaration of purpose. To assist the reader, the word ''shall'' is presented in bold characters.

1.5 Contractual Agreements In cases where the stated parameters are inappropriate or insufficient, alternate parameters may be agreed upon between vendor and user.

2.0 APPLICABLE DOCUMENTS

The following documents of the issue in effect on the date of issuance of this specification, form a part of this specification to the extent specified herein. Subsequent issues of,

or amendments to, these documents may become a part of this specification.

2.1 IPC[1]

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

IPC-PC-90 General Requirements for Implementation of Statistical Process Control

IPC-QL-653 Qualification of Facilities that Inspect/Test Printed Boards, Components and Materials

IPC-MQP-1710 OEM Standard for Printed Board Manufacturers' Qualification Profile (MQP)

IPC-1000047 Master Drawing for 10 Layer Multilayer Printed Boards (Qualification Board Series #2)

2.2 International Standards Organization[2]

ISO 9000 Quality Systems Model for Quality Assurance in Production and Installation

3.0 REQUIREMENTS

3.1 General Printed boards furnished under this specification **shall** meet or exceed all the requirements of the specific class of this specification as required by the procurement documentation. Boards furnished under this specification **shall** be as specified on the procurement documentation. They **shall** be fabricated from design information that includes sufficient coupons to facilitate the testing requirements of the class and type to which the boards were produced. Test coupons **shall** be located per the appropriate design specification or as agreed upon between user and supplier with the intent that they be as similar as possible to the board(s) they represent on the panel. Other additional coupons may be added at the discretion of the board supplier for product and/or process verification and control, as needed. Although conformance to the detailed requirements may be determined by examination of specific quality control coupons, these requirements apply to all coupons or sample boards and to deliverable printed boards, and they are based on the assumption that the boards were designed per the appropriate design specification.

3.2 Terms and Definitions The definitions of all terms used herein **shall** be as specified in IPC-T-50 and/or defined in the reference section.

3.2.1 Printed Board Procurement Documentation Consists of Purchase order or contract, the master drawing or detail specification, production drawings, master patterns, or electronic database as applicable.

3.3 Printed Board Detail Requirements The individual item requirements for printed boards delivered under this specification **shall** be documented in the applicable Sectional Specification and in the printed board procurement documentation.

Verification of compatibility with specifications, master drawings and patterns, and the specific manufacturing facilities and processes used, are the responsibility of the supplier. The printed board procurement documentation **shall** be prepared in accordance with the applicable design specifications. The supplier **shall** ensure that the end-product board meets the requirements of the printed board procurement documentation.

The procurement documentation should specify the following:

A. Title, number, issue, revision letter, and date of current applicable master drawing.

B. Specific exceptions, variations, additions or conditions to this specification that are required by the user.

C. Part Identification and Marking instructions.

D. Information for preparation for delivery, if applicable.

E. Special tests required and frequency.

3.3.1 Production Master The printed board supplier or user may produce the production master by several different methods. The printed board user is responsible for the accuracy of the information in the data base from which the production master is generated when either the production master or data base is furnished by the user to the printed board supplier. When specified, the location of appropriate test coupon patterns as shown on the procurement documentation **shall** not be changed.

3.4 Deviations and Waivers Deviations and waivers **shall** be submitted to the user. Approval of the waiver **shall** be obtained prior to delivery of the product. Permanent deviations or waivers **shall** be incorporated in the master drawing and **shall** state where the deviation applies.

3.5 Order of Precedence In the event of conflict the order of precedence from top to bottom is as follows:

Approved Printed Board Procurement Documentation

1. IPC, 2215 Sanders Road, Northbrook, IL 60062.
2. ISO, 3 Rue de Varembe, Case Postale 56, CH-1211 Geneva, Switzerland

The applicable Performance Specification

The Generic Specification

3.6 Qualification Assessment The supplier **shall** produce an assessment of their capabilities and sources of verification for a product user to evaluate. The user must then review this assessment and determine whether the information and verification provided constitutes an acceptable level of risk. There is no minimum level of Qualification Assessment Verification required by this specification. It is between the User and Supplier to determine the extent of verification which is applicable to their requirements. The cost associated with insuring an acceptable level of risk varies with the type of verification that is determined to be necessary. A detailed Qualification Assessment listing of participating suppliers is kept by the IPC in the form of IPC-MQP-1710, and is available either electronically or in hard copy from the IPC. As an example, IPC-MQP-1710 is the current qualification assessment listing for rigid printed boards. The following are guidelines for implementation of Qualification Assessment using the IPC-MQP-1710.

3.6.1 Self Declaration The first level of Qualification Assessment is self declaration. Suppliers of printed boards **shall** assess their manufacturing capability, and complete the Suppliers' Qualification Profile, IPC-MQP-1710. A completed IPC-MQP-1710 contains a profile of a supplier's site capability, processing and test equipment, technology specifics, quality program, manufacturing history, company information, and data verification sources. Self declaration is the supplier's view of his product and process capability to meet the user requirements, the requirements of this standard, and the applicable sectional specification.

3.6.2 Verification of Product Characteristics in the Self Declaration The information contained in the self declaration can be based upon data from a variety of both internal and external sources. Data on product parameters is verified by using information obtained from testing and analysis.

3.6.2.1 Production Data The results of measurements, inspections, and tests on printed boards or conformance coupons used to verify compliance to the parameters of the applicable performance specification. This data may also be in the form of statistical methods to reduce variation.

3.6.2.2 User Correlation Verification of product characteristic compliance may be demonstrated through statistically significant correlation between supplier and user inspection and test results.

3.6.2.3 Sample Qualification Parameter verification by Sample Qualification signifies that a supplier was capable of producing a product with a given set of parameters at a point in time when the Qualification sample was manufactured. This test can be performed on either the Standard Qualification Board found in IPC-A-100047, or supplier defined to simulate the production processes, materials, and construction techniques in the manufacture of printed boards as defined by the supplier's self declaration. Qualification samples can be actual production printed boards, conformance coupons specifically designed for this purpose, or other media used to establish the printed board supplier's self declaration. Qualification Test samples **shall** be manufactured using essentially the same materials, equipment, and processing procedures that are used in production. Qualification sample testing **shall** be performed at a facility which has demonstrated compliance with IPC-QL-653.

3.6.3 Verification of Quality Profile in Self Declaration The information contained in the self declaration can be based upon data from a variety of both internal and external sources. Data on the quality profile is verified by using the results of internal assessment, user assessment, or third party assessment. The results of assessments should be used to update the self declaration.

3.6.3.1 Internal Assessment Internal assessment consists of periodic supplier verification of data contained in the Quality Profile section of the self declaration.

3.6.3.2 User Assessment User assessment generally consists of on site verification of data contained in the quality profile section of the self declaration. The coordination of individual audits and audit data between several users permits a thorough review, maximizing user and supplier resources by sharing of audit philosophies and expertise.

3.6.3.3 Independent Third Party Assessment Assessment performed by a third party assessor which is generally procedural in nature. Examples of third party assessors are ISO Registrars, Government Agencies, Malcolm Baldridge, U.L., C.S.A., IECQ, etc.

3.6.4 Verification of Product Performance Characteristics in Self Declaration The information contained in the Self Declaration is based upon data from a variety of both internal and external sources. Data on product performance is verified by reviewing the results of actual performance or accelerated testing.

3.7 Quality Assurance Program A quality assurance program for manufacturing of printed boards furnished under this specification **shall** be established and maintained. The ISO 9000 Quality Assurance Systems series is a standard system that will satisfy the requirements of this specification. Specific product testing **shall** be as shown in

the associated product performance specification or as agreed upon between user and supplier.

3.7.1 Process Control The supplier **shall** have a process control system. IPC-PC-90 (see Section 6.1) is a standard statistical process control system that will satisfy the requirements of this specification.

3.8 Material All materials used in the construction of printed boards **shall** comply with applicable specifications and the printed board procurement documentation.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection The supplier is responsible for the performance of all inspection requirements specified herein. The user reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Test Equipment and Inspection Facilities Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit the performance of required inspection **shall** be established and maintained in accordance with IPC-QL-653.

4.1.2 Contract Services The supplier may contract any portion of his manufacturing operation to a contract service. If requested by the user, the supplier **shall** state what portions of manufacturing operation are contracted to a contract service. The supplier assumes all responsibility that the contract service has demonstrated the ability to meet the applicable requirements of the specification.

4.2 Materials Inspection Materials inspection **shall** consist of certification, supported by verifying data based on statistical sampling that all materials which become a part of the finished product are in accordance with the printed board procurement documentation.

4.3 Quality Conformance Inspection Quality conformance inspection **shall** be performed using either quality conformance coupons and/or production boards.

4.3.1 Inspection of Product for Delivery The quality of a product for delivery **shall** have been verified through Quality Conformance inspections as indicated in the appropriate Performance Specification. Delivery of products that have passed Quality Conformance inspection shall not be delayed pending the results of any imposed Reliability Assurance inspections.

4.3.2 Quality Conformance The Performance Specification **shall** identify the criteria to be used for determining sample size, test specimen, and frequency of testing.

4.3.2.1 Inspection Lot Production boards may be combined to form an inspection lot. An inspection lot **shall** consist of all printed boards fabricated from the same materials, using the same processing procedures and construction, produced under essentially the same conditions within a maximum period of one month and offered for inspection at one time.

4.3.2.2 Traceability Traceability **shall** be maintained for all inspection lots and combined lots. Quality conformance test circuitry (separated coupon) **shall** be traceable to the corresponding production boards, produced on the same panel.

4.3.2.3 Acceptance Acceptance of product for delivery **shall** be based on product that has passed the testing requirements shown in the applicable Performance Specification. When sampling plans are used, any failure on any of the samples identified per the Performance Specification requirements shall constitute a failure of the entire inspection lot, and **shall** be processed in accordance with the requirements of paragraph 4.3.2.4.

4.3.2.4 Rejected Lots If an inspection lot is rejected, the supplier **shall** screen out the defective units, i.e. 100% lot inspection, or other documented supplier quality system. The defective units shall be dispositioned per the supplier's quality system.

4.4 Reliability Test and Evaluation Reliability inspection **shall** consist of the Reliability Tests and Evaluations required by the Performance Specification. They shall be performed at a facility which meets all the requirements of IPC-QL-653.

4.4.1 Noncompliance If samples fail the reliability test and evaluation, the supplier **shall** take corrective action. Once the process or material responsible for the failure has been identified, no boards can be produced using that process or material until corrective action has been taken. Additionally, all product that was produced with that process or material in the interim is suspect and additional testing may be performed to insure its reliability. The supplier **shall** notify all recipients of boards that are deemed suspect. After corrective action is completed, reliability inspections **shall** be performed to confirm corrective action was successful prior to shipment of any product.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging Printed boards **shall** be packed in accordance with the minimum packaging which will afford adequate protection against corrosion, deterioration, and physical damage during shipment from the supply source to the first destination. Methods of packaging shall be determined by user requirements.

6.0 NOTES

6.1 Statistical Process Control (SPC) When IPC-PC-90 is used to implement Statistical Process Control (SPC), the following guidelines apply. Appendix A is an illustration of items that need to be addressed when implementing IPC-PC-90.

SPC uses systematic mathematical techniques to analyze a process and its outputs. The purpose of these analyses is to take appropriate actions to achieve and maintain a state of statistical control and to assess and improve process capability. The primary goal of SPC is to continually reduce variation in processes, products, or services. This is in order to provide product meeting or exceeding real or implied user requirements. Depending on the progress made in implementing SPC on a particular product, an individual supplier may demonstrate compliance to specification using any of the following:

Quality Conformance Evaluations specified in the applicable Performance Specification.

End-Product Control, In-Process Control, or Process Parameter Control as defined in the Continuous Improvement Plan of IPC-PC-90.

An individual supplier may choose to use a combination of the four assurance techniques listed above to prove compliance. For example, a product with 15 characteristics may meet specifications by Quality Conformance Evaluations on 2 characteristics, in-process product evaluations on 5 characteristics and process parameter control for 5 characteristics. The remaining 3 characteristics meet specification by a combination of in-process control and quality conformance evaluations. Evidence of compliance to the specification at the level of SPC implementation claimed may be audited by the user or appointed third party.

Requirements may be stated as reduction of variation around a target value (in terms of Cpk or other target-based capability index), as opposed to just meeting the specification, drawing, etc.

6.1.1 Reduction of Quality Conformance Testing The primary goal of SPC is not the reduction of quality conformance testing. However, as a result of understanding and control of highly capable process and product parameters, quality conformance testing may be reduced in an orderly fashion to an audit function in accordance with the following criteria, provided:

a. A documented SPC Program per the requirements of IPC-PC-90 is in place and up to date. The Audit Templates developed to support IPC-PC-90 (IPC-PC-90/1) represent a structured and standardized method that should be used for implementation, maintenance, and assessment of an SPC Program.

b. The process or processes that affect the product characteristic being evaluated have been identified, have been included in the Control Plan, and have been documented as being in a state of statistical control. Product characteristics resulting from this plan have demonstrated a capability above a minimum specified value.

c. A corrective action discipline is in place for discoveries of, and reaction to, out of control and discrepant points.

d. The measurement system by which the processes are measured has been validated per IPC-PC-90, and has demonstrated a minimum of a four-to-one uncertainty ratio (25% Gage R&R).

e. A documented Audit Plan is defined to monitor process output that includes an action plan in the event of an audit failure. The plan addresses corrective action if an audit discovers a discrepancy.

f. Current quality evaluation techniques have not exhibited any non-conformance for a period of time or a number of lots, as agreed to between user and supplier.

6.1.2 Audit Plan The Audit Plan should be designed to confirm that the SPC Program is being implemented correctly and to confirm that the implementation of the program achieves continuing improvement. The Audit Plan that is put in place after replacement of quality conformance testing **shall** include provisions for action to be taken when out-of-specification conditions are found. The action plan **shall** include the following items:

- a complete description of the problem;
- a complete description of the root cause for the failure;
- a description of the potential impact on product quality;
- a containment and short-term corrective action to preclude continuing shipment or production of nonconforming product, if applicable;
- a description of the planned long-term corrective action that will eliminate future recurrence of nonconformance and rules to revert back to the original control plan as documented in the SPC Program.

APPENDIX A

The following elements all need to be addressed when planning and implementing an SPC piece program.

Parameter Identification: Defining, selecting, and ranking candidate parameters for control by applying statistical methods; and confirming capability of measurement systems. Reference of IPC-PC-90/1, ''Audit Templates.''

Parameter Diagnostic: Identifying and classifying major sources of existing parameter variation into major unique categories, such as within-piece, piece-to-piece, and chronological. Reference of IPC-PC-90/1, ''Audit Templates.''

Parameter Control: Defining objectives or targets; collecting appropriate data; analyzing the data; and continually moving the process closer to target and taking steps to reduce its variability. Reference of IPC-PC-90/1, ''Audit Templates.''

Parameter Capability Assessment: Defining objectives; characterizing the process parameter's shape; define specification limits or operating limits and target values; and measuring the inherent long-term capability and the short-term variability of process, product, or service parameters; continually improving process capability. Reference IPC/PC-90/1, ''Audit Templates.''

Parameter Analysis: Defining objectives; selecting test variables; establishing test settings, developing test plans; establishing sampling requirements; conducting test; analyzing test data; confirming test results; and using data to manage the process. Reference IPC-PC-90/1, ''Audit Templates.''

Example of Systematic Path to the Implementation of SPC

Parameter Identification: In accordance with the principles of IPC-PC-90, the techniques of brainstorming, cause and effect diagrams, and Pareto analysis were used to identity the three major problems in a particular shop manufacturing rigid printed boards:

1. Panel not square;
2. Crazing;
3. Edge Delamination.

Based on a need to attack the major problem as identified by Pareto we will concentrate our efforts on edge delamination.

A process flow chart of the manufacturing area was constructed.

A brainstorming session was conducted to list potential causes of edge delamination.

- Feed and speed of router bit
- Age of the bit used
- Design of bit
- Measurement system
- Sharpness of bit
- Type and quality of entry and backup material
- Spindle runout
- Stack height
- Direction of travel
- Single or double pass route
- Color of laminate

Screen out and rank the most significant candidates.

- Feed and speed of the router bit
- Age of the bit used
- Design of bit
- Direction of travel
- Single or double pass route
- Spindle runout

An experiment was conducted to identity the most significant contributors.

- Design of bit
- Double pass route
- Spindle runout

By experimental results, the small design size and the double pass technique was adopted. In addition, specification limits were derived for spindle runout.

Parameter Control: Bit design was controlled by selection. Double pass route was controlled by programming. Spindle runout was controlled by utilization of control chart techniques.

Parameter Capability: Define internal specifications for spindle runout in order to define capability to assure end product conformance requirements. Acceptable ratio was set at a Cpk of 1.33. The capability was assessed at a Cpk of 1.65. Continual monitoring system was put into place.

Parameter Diagnostics: Trend analysis and multi-vari charts were used to reduce variation and thus promote continual improvement.

Parameter Analysis: It was determined that run-to-run variation was the largest contributor to the variation in spindle runout.

1. Conditions for Reduced Testing (Agreed upon between customer and supplier.)

Attained or exceeded Cpk, Cp, or PPM values per specified number of units. Demonstrate processes are in statistical control. Have prepared Process Flow and Control/Inspection Points Chart and have identified product characteristics in IPC-PC-90/1, ''Audit Templates.''

Note: Time constraints are unacceptable because time lapsed and quality attained are not likely to correlate. Lot requirements are unacceptable because lot size may range from 1 to a large number.

2. Reduced Testing Sample Size (Agreed upon between customer and supplier.)

   Performance specification group must analyze individual conformance test requirements for logical reduced sample size.

3. Conditions for Audited Control Plan (Agreed upon between customer and supplier.)

   Have exceeded conditions for Reduced Testing Sample Size. Processes are well known so that out-of-conformance conditions are highly unlikely. Conditions exceeded are to be specified.

Table A–1 Printed Circuit Fabrication—Potential Cause and Effect Matrix

		Raw Material	Sheer	Marking	Cleaning	Resist Lamination	Expose	Develop	Etch	Strip	Oxide Coat	Prepreg Preparation	Multilayer Lamination	Drilling	Hole Preparation	Electroless Copper	Flash Copper	Electroplate	Clean	Resist Lamination	Expose	Develop	Copper Electroplate	Tin/Lead Electroplate	Resist Strip	Etch	Tin/Lead Reflow	Clean	Solder Mask Lamination	Expose	Develop	Cure	Hot Air Level	Contour	Mark
Observed Attributes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Edges																																	X	
Surface imperfections	Resin starvation	X																																
Surface imperfections	Extraneous copper																		X		X	X	X	X	X									
Surface imperfections	Scratches, pits and dents	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X
Foreign inclusion		X																																
Subsurface imperfection	Blistering	X																																
Subsurface imperfection	Delamination									X	X	X																						
Subsurface imperfection	Pink ring										X	X	X	X	X	X	X																	
Plating voids in the hole														X	X	X	X																	
Marking				X																														
Solderability																X	X					X	X			X			X	X	X	X	X		
Plating adhesion		X														X	X					X	X			X	X						X		
Edge board contact																							X						X	X		X	X		
Workmanship		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Board dimension requirements	Contoured features																																	X	
Board dimension requirements	Thickness	X										X	X																						
Board dimension requirements	Hole pattern accuracy												X	X																					
Board dimension requirements	Front to back registration													X						X															
Board dimension requirements	Internal registration						X	X	X				X	X																					
Board dimension requirements	Annular ring													X						X															
Board dimension requirements	Bow & twist	X											X	X																					

		Raw Material	Sheer	Marking	Cleaning	Resist Lamination	Expose	Develop	Etch	Strip	Oxide Coat	Prepreg Preparation	Multilayer Lamination	Drilling	Hole Preparation	Electroless Copper	Flash Copper	Electroplate	Clean	Resist Lamination	Expose	Develop	Copper Electroplate	Tin/Lead Electroplate	Resist Strip	Etch	Tin/Lead Reflow	Clean	Solder Mask Lamination	Expose	Develop	Cure	Hot Air Level	Contour	Mark
Observed Attributes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Conductor definition	Width																			X	X		X		X										
Conductor definition	Spacing																			X	X		X		X										
Conductive surfaces	Nicks, dents & pinholes										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Conductive surfaces	Dewetting																				X	X	X			X			X	X	X	X	X		
Conductive surfaces	Nonwetting																				X	X	X			X			X	X	X	X	X		
Conductive surfaces	Edge board connector lands																		X	X	X		X	X	X										
Conductive surfaces	Surface mount lands																		X	X	X		X	X	X										
PTH integrity	Plating voids													X	X	X	X					X													
PTH integrity	Folds/ inclusion													X	X		X					X													
PTH integrity	Burrs/ nodules													X	X		X					X													
PTH integrity	Glass fiber/ protrusion													X	X		X					X													
PTH integrity	Wicking												X			X																			
Laminate integrity	Resin recession	X												X	X	X	X	X					X												
Laminate integrity	Laminate voids									X	X	X																							
Etchback														X	X																				
Negative etchback		X												X	X	X	X																		
Lifted lands		X											X																				X		
Dimensional evaluation	Plating thickness															X	X					X	X												
Dimensional evaluation	IO conductor thickness	X			X				X		X																								
Dimensional evaluation	Surface conductor thickness	X													X	X	X	X				X	X		X		X	X							
Dimensional evaluation	Conductor edge outgrowth																			X	X	X	X	X	X	X									
Dimensional evaluation	Annular ring internal										X	X	X	X	X	X																			
Dimensional evaluation	Metal cores	X											X	X																					
Dimensional evaluation	Dielectric spacing	X											X	X																					

		Raw Material	Sheer	Marking	Cleaning	Resist Lamination	Expose	Develop	Etch	Strip	Oxide Coat	Prepreg Preparation	Multilayer Lamination	Drilling	Hole Preparation	Electroless Copper	Flash Copper	Electroplate	Clean	Resist Lamination	Expose	Develop	Copper Electroplate	Tin/Lead Electroplate	Resist Strip	Etch	Tin/Lead Reflow	Clean	Solder Mask Lamination	Expose	Develop	Cure	Hot Air Level	Contour	Mark
Observed Attributes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
PTH after thermal stress	Interplane seperation										X	X	X	X	X	X	X					X												
PTH after thermal stress	Interplane inclusions											X	X	X	X	X																		
PTH after thermal stress	Innerlayer foil cracks	X													X		X					X												
PTH after thermal stress	External foil cracks	X															X					X												
PTH after thermal stress	Barrel cracking													X	X	X	X					X	X												
PTH after thermal stress	Plating seperation															X	X	X	X	X	X	X	X									X	X		
PTH after thermal stress	Pullaway lifted lands													X	X	X	X																		
PTH after thermal stress	Lifted lands	X																															X		
PTH after thermal stress	Plating voids													X	X	X	X																		

ASSOCIATION CONNECTING
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IPC-6011

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1. I recommend changes to the following:

___ Requirement, paragraph number _____

___ Test Method number _____, paragraph number _____

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other _____

2. Recommendations for correction:

3. Other suggestions for document improvement:

Submitted by:

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☐ Mixed Technology
☐ Consignment
☐ BGA

Name of Chief Executive Officer/President_____

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