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Requirements for Electrical Testing of Printed Electronics E-Textiles

Developed by Printed Electronics E-Textiles Electrical Test Task Group (D-74a) of the E-Textiles Committee (D-70) of IPC

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 Printed Electronics E-Textiles Electrical Test Task Group (D-74a) of the E-Textiles Committee (D-70) of IPC 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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1 SCOPE

This document is intended to assist in selecting the test equipment, test parameters, test data and fixturing required to perform electrical test(s) on printed electronics on e-textiles.

Printed electronics on e-textiles are printed electronics on coated or treated textile substrates.

Coatings and treatments may be applied for printability of the textile substrate and/or for performance of the textile substrate or finished printed electronics e-textile (e.g., hydrophobic, water retardance, flame retardance, surface energy). Coatings or treatments may be applied using printing, lamination or other processes.

1.1 Purpose Electrical testing verifies that the conductive networks on the printed electronics on e-textile are interconnected according to the design requirements. Electrical testing does not ensure that the printed electronics on e-textile can be assembled or that the printed electronics on e-textile meets all of the customer's requirements. Many physical characteristics of the conductors (e.g., dimensional accuracy, conductor geometry and registration, presence of holes) cannot be determined by electrical test. Other checks should be employed to confirm these characteristics.

1.1.1 Introduction Electrical testing of printed electronics on e-textile ensures conformance to the electrical design requirements. This document defines different levels of testing available to achieve this purpose. In selecting the appropriate test level, technology, equipment and associated fixturing, a suitable compromise between productivity, features and costs can be found.

1.1.2 Costs of Test Equipment The costs associated with electrical testing can vary dramatically. Costs alone, however, should never be the only criteria for selecting the appropriate test level and equipment. As shown in Figure 1-1, many other important areas require consideration. For example, spacing and density of a printed electronics on e-textile design may be of paramount importance to one user, while another may be concerned with testing parameters and service reliability. Therefore, a careful examination of all areas of concern and how they may affect each other, not just how they perform individually, is significant. Whatever the selection criteria may be, qualifying benchmarks should be performed on known test equipment.

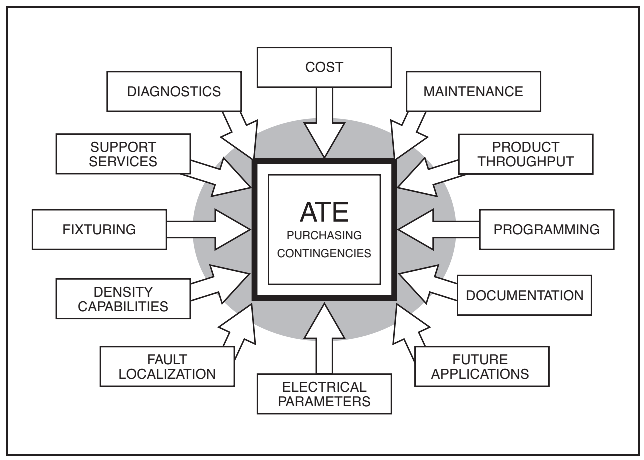

Figure 1-1 Automatic Test Equipment (ATE) Selection Criteria

1.2 Classification IPC standards recognize that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional performance requirements and verification (inspect/test) frequency. It should be recognized that there may be overlaps of equipment between classes.

CLASS 1 General Electronics Products
Includes products suitable for applications where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Service Electronic Products
Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

CLASS 3 High Performance/Harsh Environment Electric Products
Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-user environment may be uncommonly harsh, and the equipment and must function when required, such as life support or other critical systems.

1.2.1 Selection of the Proper Test Level All testing levels (see Section 3) defined in this document are intended to check electrical functionality of the design. However, the test level specified will affect test comprehensiveness. For example, when selecting test voltages and resistances for the printed electronics on e-textile, the user needs to consider both the final application of the printed electronics on e-textile and the level of defect analysis needed to ensure acceptable product. Electrical testing parameters that allow high productivity could also allow higher defect escape rates.

It is the responsibility of the user, of the standard, to select the test level desired. If nothing is specified, IPC Class 1, Class 2 and Class 3 will be tested to Level A, B and C, respectively. The user **shall** determine the test parameters to test for continuity (open), isolation (leakage/short) and other special characteristics (e.g., Impedance, hi-pot, capacitance, current carrying capacity) that will satisfactorily evaluate the critical electrical characteristics of specific printed electronics on e-textile.

1.3 Measurement Units All dimensions and tolerances in this specification are expressed in hard SI (metric) units and bracketed soft imperial [inch] units. Users of this specification are expected to use metric dimensions. All dimensions ≥ 1 mm [0.0394 in] will be expressed in millimeters and inches. All dimensions < 1 mm [0.0394 in] will be expressed in micrometers and microinches.

1.4 Definition of Requirements The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawing and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

1.5 Process Control Requirements The primary goal of process control is to continually reduce variation in the processes, products, or services to provide products or processes meeting or exceeding User requirements, Process control tools such as IPC-9191, JEDEC JESD 557 or other User-approved system may be used as guidelines for implementing process control.

Manufacturers of Class 3 products **shall** develop and implement a documented process control system.

A documented process control system, if established, **shall** define process control and corrective action limits.

This may or may not be statistical process control system. The use of “statistical process control” (SPC) is optional and should be based on factors such as design stability, lot size, production quantities, and the needs of the Manufacturer.

Process control methodologies **shall** be used in the planning, implementation and evaluation of the manufacturing processes used to produce soldered electrical and electronic assemblies. The philosophy, implementation strategies, tools and technologies may be applied in different sequences depending on the specific company, operation, or variable under consideration to relate process control and capability to end product requirements.

When a decision or requirement is to use a documented process control system, failure to implement process corrective action and/or the use of continually ineffective corrective actions **shall** be grounds for disapproval of the process and associated documentation.

1.6 Order of Precedence The contract **shall** take precedence over this standard, referenced standards and drawings.

In the event of conflict, the following order of precedence applies:

1) Procurement as agreed and documented between customer and supplier
2) Master drawing reflecting the customer's detailed requirements
3) When invoked by the customer or per contractual agreement, this standard

When documents other than this standard are cited, the order of precedence **shall** be defined in the procurement documents. The user can specify alternate acceptance criteria.

1.6.1 Conflict In the event of conflict between the requirements of this standard and the applicable drawing(s) and documentation, the applicable user-approved drawing(s) and documentation govern.

Some examples of documentation include the contract, purchase order, technical data package, engineering specification or performance specification. In the event of a conflict between the text of this standard and the applicable documents cited herein, the text of this standard takes precedence. In the event of conflict between the requirements of this standard and drawing(s) and documentation that has not been user approved, this standard governs.

1.6.2 Clause References When a clause in this document is referenced, its subordinate clauses apply, unless the requirement references specific subordinate clauses.

1.6.3 Appendices Appendices to this standard are not binding requirements unless separately and specifically required by this standard, the applicable contracts, assembly drawing(s), documentation or purchase orders.

1.7 Use of “Lead” For readability and translation, this document uses the noun lead only to describe leads of a component. The metallic element lead is always as Pb.

1.8 Abbreviations and Acronyms Periodic table elements are abbreviated in the standard. See Appendix A for full spellings of acronyms used in this standard.