

JEDEC PUBLICATION

Guidelines for Particle Impact Noise Detection (PIND) Testing, Operator Training, and Certification

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GUIDELINES FOR PARTICLE IMPACT NOISE DETECTION (PIND) TESTING, OPERATOR TRAINING AND CERTIFICATION

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GUIDELINES FOR PARTICLE IMPACT NOISE DETECTION (PIND) TESTING, OPERATOR TRAINING AND CERTIFICATION

(From JEDEC Board Ballot JCB-23-12, formulated under the cognizance of JC-13 Committee on Government Liaison.)

Introduction

All modern systems for military, space and satellite applications use many electronic components that perform complex control, navigational and monitoring functions of the systems. Proper functioning of these devices without interruptions is vital to the success of the missions and safety of the personnel and equipment. Towards achieving this objective, electronic components are manufactured and tested in accordance with the controls and requirements of applicable military standards, specifications and drawings. One critical factor that can cause catastrophic device failure is loose particles within the components.

The focus and importance of screening devices for particles occurred when a catastrophic system failure in the Delta Launch Vehicle Program was traced to a loose bit of wire within an electronic component. (1, 2, 3)

The significance of screening devices for particles was further elevated because of advances in the manned space vehicle, satellite and missile programs. As a result, space-level devices (Class S) and Class B devices that are used in flight and missile applications must be particle-free.

NASA, McDonnell Douglas and Texas Instruments developed and constantly improved techniques of detecting particles audibly and visibly within device cavities. A finalized version of the audible technique was adopted as a Particle Impact Noise Detection Test procedure "PIND" in MIL-STD-883, Test Method 2020. (4, 5, 6)

Despite progress in regard to testing concepts, PIND tester design, methods and media of attachment, there still exists a lack of correlation between equipment, inconsistency in the test results and conditions, lack of repeatability and false detections. (7, 8, 9, 10, 11) As a result, there is a general tendency by manufacturers to question the reliability of the PIND test.

Still PIND testing remains the key measuring indicator for controlling and maintaining a reliable process line relative to particle contamination. It is a useful tool to continuously refine and improve the assembly process.

Even though a wealth of information and knowledge about PIND test resides with various users and manufacturers, it is fragmented or communicated in the proceedings of various symposiums, NBS and NASA report, but not in an organized complete document on the subject.

The main objective of this Publication is to disseminate and share the relevant information on PIND testing to all interested parties. The concepts and materials presented here primarily deal with most of the cause factors that affect the "Measurement Variability" pertinent to "PIND" and how to control them.

Scope

This publication is intended only as a guideline to test facilities in their efforts to establish and maintain consistent PIND testing. Imposition of these suggestions, or any part thereof, is within the province of each test facility as to its respective needs.

SECTION I reviews specific PIND requirements on electronic devices and manufacturer facilities to satisfy customer needs and military specifications.

SECTION II discusses representative sources of particles that may be generated during device manufacturing. However, it should be noted that the nature, type and sources of particles can vary widely in different manufacturing facilities with different technologies, materials and processes and in no way is limited to those mentioned here. (12, 13)

SECTION III covers most aspects of the PIND system including test principles, calibration and maintenance, device attachment mediums and sources of interference and prevention methods.

SECTION IV covers operator education, training and certification. It is a guide to users for elimination of false particle detection due to improper testing by operators.

SECTION V covers the methods of loose particle recovery and failure analysis of PIND failures. The section includes process control measures for PIND testing and references made to product quality verification is included. With measurement consistency and reliable PIND results achievable and in control, manufacturers will be able to focus on the root causes of particles in the products and processes and will be able to eliminate the defects to enhance the device quality.

SECTION VI covers a brief summary of this publication.

JEDEC acknowledges that these publication materials are derived from information from the list of references, from participant companies' internal documents and discussions from PIND Task Group meetings of the JEDEC JC-13 (Government Liaison) and JC-13.5 (Government Liaison - Hybrid Microcircuit Technology) Committees.

SECTION 1

1.1 Specific test requirements

Before embarking on the PIND issues and problems in testing, a review of the specific test requirements (6) and constraints on the electronic device is in order. These requirements are imposed on manufacturers through government documents by procuring agencies and end-system users. The specific test methods are listed in MIL-STD-750, Test Method 2052 and MIL-STD-883, Test Method 2020. Examples of the requirement stipulations fall broadly under the following categories:

- a) Class S device level requirements specified via device screening per Test Methods 5004 and 5010 of MIL-STD-883.
- b) Class B device level and customer-specific requirements imposed via specifications.
- c) Manufacturer line certification and/or process qualification requirements imposed via Performance Specification e.g. MIL-PRF-38535, MIL-PRF-19500, MIL-PRF-38534
- d) Manufacturer process stability imposed through internal process controls and audits.
- e) PIND test requirements outlined in MIL-PRF-38535, MIL-PRF-19500, and MIL-PRF-38534.
- f) Devices not being PIND tested (e.g., waiting for test or completed test) should be located a minimum of 12-inches away from the side of the magnetized shaker portion of the PIND test equipment.
- g) Degaussing may be effective depending on the particle type and the package construction. Degaussing is allowed but it is not required.

1.2 Acceptance conditions

1.2.1 MIL-PRF-38535 requirements for in-line screening of Class S devices

For microcircuits, the inspection lot (or sublots) shall be submitted to 100% PIND testing a maximum of five times in accordance with Method 2020 of MIL-STD-883, Condition A. PIND prescreening shall not be performed. The lot may be accepted on any of the five runs if the percentage of defective devices (PDA) is less than 1% (or one device, whichever is greater). All defective devices shall be removed after each run. Lots that do not meet the 1% PDA on the fifth run, or cumulatively exceed 25% defective shall be rejected and resubmission is not allowed.

1.2.2 MIL-PRF-38534 requirements for in-line screening of Class K devices

For hybrids, the inspection lot (or sublots) shall be submitted to 100% PIND testing a maximum of five times in accordance with Method 2020 of MIL-STD-883, Condition A or B (when specified). PIND prescreening shall not be performed. The lot may be accepted on any of the five runs if the percentage of defective devices (PDA) is less than 1% (or one device, whichever is greater). All defective devices shall be removed after each run. Lots that do not meet the 1% PDA on the fifth run, or cumulatively exceed 25% defective shall be rejected and resubmission is not allowed.

1.2.3 MIL-PRF-19500 requirements for in-line screening of JANTX, JANTXV and JANS devices

For semiconductors, the inspection lot (or sublots) shall be submitted to 100% PIND testing a maximum of five times in accordance with Method 2052 of MIL-STD-750, Condition A or B (when specified). PIND prescreening shall not be performed. The lot may be accepted on any of the five runs if the percentage of defective devices (PDA) is less than 1% (or one device, whichever is greater). All defective devices shall be removed after each run. Lots that do not meet the 1% PDA on the fifth run, or cumulatively exceed 25% defective shall be rejected and resubmission is not allowed.

1.2.4 Manufacturer and customer required tests

Manufacturer and customer required tests are usually imposed through specification control drawings by the customer for Class B or H level products that are used in flight or missile applications. The accept/reject criteria are specified in these documents.

1.2.5 Quality assurance requirements (reference MIL-PRF documents)

Devices or lots that have failed to pass any test applied or acceptance criteria (PDA) shall not be downgraded to any lower quality assurance level, even though the test or criteria may not be a requirement of the lower level. (Failed devices or lots shall not be accepted.) (Ref. MIL-PRF-38535, MIL-PRF-19500 and /or MIL-PRF-38534.)

1.2.6 Qualification and manufacturer-imposed test (reference MIL-PRF documents)

When a test detects a problem (such as loose particles), the manufacturer shall subject all devices in the lot to those tests to eliminate rejects, and shall take steps to determine and eliminate the cause of failure. (Ref. MIL-PRF-38535, MIL-PRF-19500, MIL-PRF-38534)

SECTION 2

2.1 Sources of particles

Loose particles within electronic components can come from many sources. There have been extensive studies in this area to identify the types of particles that may be trapped within devices and to determine their source. The particle sources are generally listed under the following categories:

2.1.1 Material/handling

Particles in the form of foreign material may be introduced into devices during pre-seal handling and during assembly. Although some of these particles may appear to be attached during inspection, when subjected to thermal and mechanical stresses, they can loosen and dislodged from internal components of the device.

Trays or chip carriers used repeatedly without proper cleaning are a major source of unattached foreign material, such as silicon or ceramic dust. These can be trapped within the device during assembly. Similarly, lids being shipped, stored and carried in cardboard or other fiber-emitting material are an uncontrolled source of particles.

The third example is glass splatters on metal packages. During the glass-bead-attach process, the glass may splatter, leaving small particles of glass unconnected to the bead, but attached to the surface of the metal. Failure analysis has shown that these glass particles can become detached during stresses and will cause PIND failures.

2.1.2 Processing

There are many processing steps in device assembly that may induce particles. Examples of the particles and the corresponding process steps are listed below.

PARTICLE

Fiber glass
Silicon
Epoxy flakes
Bond wire
Aluminum/gold
Ceramic
Solder balls
Weld splatter
Solder flakes
Gold flakes

PROCESS

Package cleaning
Scribing/die removal/eutectic mount
Die mount/die removal
Wire bond/rework
Wire bond/rework
Substrate scribe
Solder reflow seal
Weld seal
Eutectic mount
Eutectic mount