REVISIONS			
SYMBOL	**DESCRIPTION**	**DATE**	**APPROVAL**
B	Previous issue has been completely revised and redrawn, with editorial changes throughout the specification.	02/09/2009	JS
C	Revised completely prohibited materials section 4.1.3; removed electrical test requirements for caps, microcircuits, relays, transistors, RF devices; added definition; clarified IGA requirement	08/22/2011	JS
D	A197- Updated switch and connector sections, added new chip inductor section, added BME capacitor section, updated IGA for small volume packages, deleted 4.1.3.6.3. * used to indicate changed sections.	6/29/2015	BM

SHEET REVISION STATUS

ALL SHEETS ARE THE SAME REVISION

ORIGINATOR: Bruce Meinhold, MEI Technologies Inc.	**DATE**	**FSC: 59GP**
REVIEWED: Alix Duvalsaint, QSS Group Inc.		Specification for the Performance of Destructive Physical Analyses (DPA)
CODE 562 APPROVAL: Marcellus Proctor, NASA GSFC		
ADDITIONAL APPROVAL: Dr. Henning Leidecker, NASA GSFC		
ADDITIONAL APPROVAL:		S-311-M-70

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

CAGE CODE: 25306

1 SCOPE

1.1 Scope. This specification establishes the general requirements to be used in the performance of Destructive Physical Analysis (DPA) for Electrical, Electronic, and Electromechanical (EEE) parts. Performance of the testing required by this specification is intended to verify part lot conformance with applicable specifications and standards.

1.2 Application. This standard is intended to be referenced in part specifications or in other documents where DPA requirements are imposed, to assure that the practices, procedures, and criteria for DPA are uniformly applied.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Government specifications and standards. The following Government specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS), and supplement thereto, in effect on the date of the contract or purchase order.

SPECIFICATIONS

MILITARY

STANDARDS

MILITARY

MIL-STD-202	Test Method Standard Electronic and Electrical Component Parts
MIL-STD-750	Test Method Standard Test Methods for Semiconductor Devices
MIL–STD–883	Test Method Standard Microcircuits
MIL–STD–1580	Test Method Standard Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts

2.2 Non–Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS in effect on the date of the contract or purchase order. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents in effect on the date of the contract or purchase order.

ESD Association Standard

ANSI/ESD S20.20	ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices).

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 DEFINITIONS

3.1 Finish. As used herein, the term "finish" is used to describe all of the following: surface finish; surface plating; solder coating; solder plating.

3.2 Pure. As used to describe finishes and solders in this specification, pure is defined as containing no other elements, except for incidental contamination.

4 REQUIREMENTS

4.1 General Requirements. General requirements for this specification shall be as specified in MIL-STD-1580, Section 4, except as modified herein. DPA shall be performed on each lot or date or batch code, as applicable, used in flight hardware.

4.1.1 Large Lot Sampling Plan. The sample size, for lots where the procurement quantity of a single lot/date/batch code is two hundred (200) pieces or greater, shall be as specified in MIL-STD-1580, paragraph 4.1.1.

4.1.2 Small Lot Sampling Plan. The sample size, for lots where the procurement quantity of a single lot/date/batch code is less than two hundred (200) pieces, shall be as specified in Table I herein.

Table I. Small Lot DPA Sampling Plan

Quantity Procured	DPA Sample Size
< 5	1
5 – 15	2
16 - 50	3
51 – 199	5

4.1.3 Prohibited Materials Analysis. Internal and external prohibited materials analysis shall be performed in accordance with MIL-STD-1580, Requirement 9, and as modified herein. Techniques may include Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS), X-ray Fluorescence (XRF) Spectrometry, or another GSFC approved method. Visual inspection is not an approved method. Quantitative measurements, in % wt, are required to be provided with all spectra.

4.1.3.1 Internal prohibited materials analysis. In addition to the external examination requirements of MIL-STD-1580, Requirement 9, all DPA samples evaluated to this specification shall have all internal metallic surfaces (solders, platings, and finishes) inspected for prohibited materials. Surfaces shall include but not be limited to internal leads, terminals, metal seals and shields, die attach, and lids.

4.1.3.2 Sample Size. Sample size, for both external and internal prohibited materials analysis, shall be 100% of the DPA samples submitted for evaluation.

4.1.3.2.1 Complex hybrid devices (>20 internal elements), where all DPA samples appear to be from a homogenous (e.g. visually similar) lot, the internal inspection sample size shall be two (2) devices, or 100% of the sample size, whichever is smaller.

4.1.3.3 Acceptance Criteria. The acceptance criteria of MIL-STD-1580, Requirement 9, paragraph 9.2.6.2 shall not be used. Paragraphs 4.1.3.4 through 4.1.3.7, herein, shall govern.

4.1.3.4 Prohibited Materials. The following material findings shall be cause for lot rejection.

4.1.3.4.1 The presence of Cadmium (Cd) or Selenium (Se) (≥ 1 % wt).

4.1.3.4.2 Pure Zinc (Zn) hardware, shells, or castings.

4.1.3.4.3 Zinc (Zn) hardware, shells, or castings, with Chromium (Cr) coating.

4.1.3.5 Prohibited finishes and solders. The following finish or solder findings shall be cause for lot rejection.

4.1.3.5.1 Pure Zinc (Zn) finishes.

4.1.3.5.2 Finishes and solders containing Tin (Sn) with < 3 % wt Lead (Pb).

4.1.3.5.3 Chromium (Cr) coatings over Zinc (Zn) hardware, shells, or castings.

4.1.3.5.4 Indium (In) solder or solder paste in contact with Gold (Au) (including but not limited to wires, wire bonds, ribbons, terminations, backside metallization).

4.1.3.6 Acceptable Finishes and solders. The following finishes or solder findings are acceptable.

4.1.3.6.1 Tin (Sn) finishes or solders containing a minimum of 3 % wt Lead (Pb).

4.1.3.6.2 Gold Tin eutectic (80Au-20Sn) solder, when used for die and lid attach.

*4.1.3.6.3 Deleted.

4.1.3.7 Exceptions. Additional analyses may be authorized by the GSFC Parts Control Board, for the following special conditions.

4.1.3.7.1 Low Tin (Sn) content (≤ 60 % wt) alloys that do not contain Lead (Pb), but have been verified to contain no pure Tin (Sn) grains for whisker development, may be approved through the GSFC Parts Control Board. Note, XRF is not an acceptable tool to verify the lack of pure Tin (Sn) grains.

4.1.4 ESD Handling Precautions. Many of the devices submitted for DPA are sensitive to ESD classifications of 1C or lower. Because of this wide ranging sensitivity, an ESD handling process, in accordance with ANSI ESD S20.20 shall be in place, and ESD handling precautions shall be observed such that damage is not introduced into the specimens during the initial processing.

4.2 Detailed Requirements. Detailed requirements shall be as specified by the appropriate test requirement of MIL-STD-1580, and as modified herein.

4.2.1 Capacitors. DPA for capacitors shall be performed in accordance with MIL-STD-1580, Requirement 10, and as specified herein.

*4.2.1.1 Base Metal Electrode (BME) Capacitors. BME capacitors shall be prepared and examined in accordance with the following criteria, which substitutes for the precious metal criteria of EIA ECA-469.

*4.2.1.1.1 After cross-sectioning in accordance with EIA-469, the following additional processing shall be performed to accurately detect feature size.

*4.2.1.1.2 After finishing with grit 600, move to 800, then 1000, then 1200, then 2400 or finer before the final polish, which shall be made with sub-micron (0.3 micron or smaller) diamond or alumina powder and a short/low nap cloth. Low pressure/high flow rate water shall be used during all grinding stages.

*4.2.1.1.3 Use of either vicinal illumination (Reference: S. Hull, “Nondestructive Detection of Cracks in Ceramics Using Vicinal Illumination”, ASM International, Nov. 1999, ISBN 0-87170-646-6), or dark-field illumination with a polarizer, to inspect for cracks in the ceramic. Alternate techniques may be used with written approval by the procuring activity.

*4.2.1.1.4 Any single fired-on delamination of an interface of material layers which exceeds 20% of the interface (pertaining to the overall chip element length or width), and exceeds 0.127 mm (0.005 in) for case sizes larger than 0603 and exceeds 0.051 mm (0.002 in) for a case sizes of 0603 and smaller shall be cause for rejection.

*4.2.1.1.5 Any single delamination of an interface of material layers, in the active area, which exceeds 0.13 mm (.005 in) for case sizes larger than 0603 and exceeds 0.051 mm (0.002 in) for a case sizes of 0603 and smaller, and displaces adjacent dielectric layers by more than 50% of the average nominal dielectric thickness shall be cause for rejection.

*4.2.1.1.6 Any side margin that displays a minimum margin less than that specified below shall be cause for rejection.

Rated Working Voltage (dc)	Minimum Side Margin mm (in)
V_R < 10Vdc	0.015 (0.0006)
10Vdc ≤ V_R < 25Vdc	0.020 (0.0008)
V_R = 25Vdc	0.025 (0.001)
25Vdc < V_R ≤ 50Vdc	0.040 (0.0016)
50Vdc < V_R ≤ 200Vdc	0.050 (0.0020)
V_R > 200Vdc	Consult Manufacturer

*4.2.1.1.7 Any end margin that displays a minimum margin less than that specified below shall be cause for rejection.

Rated Working Voltage (dc)	Minimum End Margin mm (in)
V_R < 10Vdc	0.025 (0.001)
10Vdc ≤ V_R < 25Vdc	0.036 (0.0014)
V_R = 25Vdc	0.040 (0.0016)
25Vdc < V_R ≤ 50Vdc	0.050 (0.002)
50Vdc < V_R ≤ 200Vdc	0.075 (0.003)
V_R > 200Vdc	Consult Manufacturer

*4.2.1.1.8 Any cover plate that displays a minimum thickness less than that specified below shall be cause for rejection.

Rated Working Voltage (dc)	Minimum Cover Plate Thickness mm (in)
V_R < 10Vdc	0.025 (0.001)
10Vdc ≤ V_R < 25Vdc	0.036 (0.0014)
V_R = 25Vdc	0.040 (0.0016)
25Vdc < V_R ≤ 50Vdc	0.050 (0.002)
50Vdc < V_R ≤ 200Vdc	0.075 (0.003)
V_R > 200Vdc	Consult Manufacturer

*4.2.1.1.9 Any capacitor displaying a crack in the dielectric of the active area, or any crack in the enveloping ceramic margins/borders, which either reduces, or has the potential, through further propagation, to reduce the effective margins to less than the limits defined in paragraph 4.2.1.1.6 through 4.2.1.1.8 shall be cause for rejection.

*4.2.1.1.10 Dielectric thickness is the actual measured thickness of the fired ceramic dielectric layer. Voids, or the cumulative effect of voids, shall not reduce the total dielectric thickness (T) by more than 30 percent (see figure 1). Inspection for 30% reduction in the thickness of an individual dielectric layer (see figure 1) shall not apply to dielectrics less than or equal to 7 microns due to lack of consistent and repeatable measurement.

Figure 1 Dielectric Voiding

*4.2.1.1.11 Capacitors which exhibit undulations in the electrode and dielectric layers are not cause for rejection as long as electrodes and dielectric follow the same undulating pattern (see figure 2 below) without distortion of the dielectric, and the requirements of paragraphs 4.2.1.1.6 through 4.2.1.1.8 are met.

Figure 2 Acceptable undulation in electrode/dielectric layers

4.2.2 Connectors. DPA for connectors shall be performed in accordance with MIL-STD-1580, Requirement 11.

*4.2.2.1 Contacts. The plating thickness shall be measured for acceptance in the contact mating region only, as specified by the procurement specification.

4.2.3 Quartz Crystals. DPA for quartz crystals shall be performed in accordance with MIL-STD-1580, Requirement 12.

4.2.4 Diodes. DPA for diodes shall be performed in accordance with MIL-STD-1580, Requirement 13, and as specified herein.

4.2.4.1 Thermal Impedance testing. In lieu of scribe and break and cross sectioning of DPA samples, all samples may be submitted to thermal impedance testing in accordance with MIL-STD-750, Method 3101.

4.2.5 Feed Through Filters. DPA for feed through filters shall be performed in accordance with MIL-STD-1580, Requirement 14.

4.2.6 Magnetic Devices. DPA for magnetic devices shall be performed in accordance with MIL-STD-1580, Requirement 15.

*4.2.6.1 Inductor, Ferrite Bead, Solid, Chip. This construction type of magnetic device is not currently specified under MIL-STD-1580, Requirement 15. DPA process shall be as specified herein. Sample size shall be five (5) pieces.

4.2.6.1.1 External visual and mechanical examination shall be performed in accordance with the general requirements of ECA EIA-595, at a magnification of 20X, minimum. Devices which exhibit the following external visual anomalies shall be rejected.

a) Holes or voids in the body that are greater than 0.010 inch in diameter.
b) Chip/chipout in any part of the body which is greater than 0.010 inch in depth.
c) Lifting or peeling metallization at any location.
d) Voids (or the sum of voids) on any one side of the termination band or on the termination ends which exceeds 5% of the individual side area.
e) Foreign material (or the sum of foreign materials) on any one side of the termination band or on the termination ends which exceeds 5% of the individual side area.
f) Greater than 10% of the termination side areas which are reduced by chipped edges.
g) Evidence of cracks or delaminations on any component body surface areas.
f) Mechanical dimensions not in compliance with the procurement specification.

4.2.6.1.2 Five (5) samples shall be prepared for sectioning, in accordance with the guidelines of MIL-STD-1580, paragraph 4.4.2, and ECA EIA-469, paragraph 4.2.4. Samples shall be prepared for sectioning and polishing, in the following manner.

a) Three components shall be subjected to sectioning along the longitudinal axis to reveal side views of the components.
b) One component shall be subjected to sectioning from the top or bottom side to reveal a single electrode layer.
c) One component shall be subjected to lateral sectioning from either end termination, to reveal the electrode layers.

4.2.6.1.3 Complete sectioning and polishing, and acquire SEM images of each specimen. Samples which exhibit the following internal visual anomalies shall be rejected.

a) Holes/voids in the bodies which are greater than 0.005 inch in diameter.
b) Any evidence of end termination lifting or peeling. (applicable to longitudinally polished samples, paragraph 4.2.6.1.2 a, b, only)
c) Foreign particles greater than 0.005 inch in diameter.
d) Cracks or micro-cracks that run through metallization layers.
e) Cracks or micro-cracks that are less than 0.005 inches from the component body edge.

4.2.7 Microcircuits. DPA for microcircuits, including monolithic microcircuits, hybrid microcircuits, plastic encapsulated microcircuits (PEMs), hybrid optocouplers, hybrid oscillators, and multi-chip modules shall be performed in accordance with MIL-STD-1580, Requirement 16, and as specified herein.

*4.2.7.1 Internal Gas Analysis (IGA). IGA shall be performed on three (3) samples, or 100% of the parts submitted for DPA, whichever is less. Devices with an internal cavity volume 0.01cc or smaller shall be tested at a laboratory with a DLA Land and Maritime-VQ letter of suitability for small volume packages (see laboratory listings for MIL-STD-883, Method 1018, at http://www.landandmaritime.dla.mil/offices/sourcing_and_qualification/labsuit.aspx).

4.2.7.2 Bond Pull. Bond pull testing shall be performed in accordance with MIL-STD-883, Method 2011, Condition D, except all wire bonds shall be pulled to destruction, and recorded.

4.2.8 Relays. DPA for relays shall be performed in accordance with MIL-STD-1580, Requirement 17, and as specified herein.

4.2.8.1 Particle Impact Noise Detection (PIND). Perform PIND on all samples, in accordance with Appendix A, herein. Appendix A herein is reproduced here for convenience, and has been taken from MIL-PRF-39016, Revision E, Amendment 2, Appendix B.

4.2.9 Resistors. DPA for resistors shall be performed in accordance with MIL-STD-1580, Requirement 18, and as specified herein.

4.2.10 Switches. DPA for switches shall be performed in accordance with MIL-STD-1580, Requirement 19.

*4.2.10.1 Thermal Switches. In addition to the requirements of MIL-STD-1580, paragraph 19.2, thermal switch DPA samples shall be subjected to the following tests prior to sectioning.

*4.2.10.1.1 Particle Impact Noise Detection (PIND). PIND testing in accordance with MIL-STD-202, Method 217.

*4.2.10.1.2 Fine leak testing, in accordance with MIL-STD-202, Method .112, Test Condition C, Procedure III, $1E^{-8}$atm-cm^3/s maximum.

*4.2.10.1.3 Gross leak testing, in accordance with MIL-STD-202, Method 112, Test Condition D.

4.2.11 Thermistors. DPA for thermistors shall be performed in accordance with MIL-STD-1580, Requirement 20.

4.2.12 Transistors. DPA for transistors shall be performed in accordance with MIL-STD-1580, Requirement 21, and as specified herein.

*4.2.12.1 Internal Gas Analysis (IGA). IGA shall be performed on three (3) samples, or 100% of the parts submitted for DPA, whichever is less. Devices with an internal cavity volume 0.01cc or smaller shall be tested at a laboratory with a DLA Land and Maritime-VQ letter of suitability for small volume packages (see laboratory listings for MIL-STD-750, Method 1018, at http://www.landandmaritime.dla.mil/offices/sourcing_and_qualification/labsuit.aspx).

4.2.13 RF Devices. DPA for selected RF devices shall be performed in accordance with MIL-STD-1580, Requirement 22.

4.2.14 Fuses. DPA for fuses shall be performed in accordance with MIL-STD-1580, Requirement 23.

*4.2.14.1 Hollow Body Fuses. In addition to the requirements of MIL-STD-1580, Requirement 23, hollow body fuses (e.g. FM04, FM08 per MIL-PRF-23419) shall be subjected to gross leak testing in accordance with MIL-STD-202, Method 112, Condition D.

4.2.15 Heaters. DPA for heaters shall be performed in accordance with MIL-STD-1580, Requirement 24.

4.2.16 Parts Not Previously Identified. Parts not included in the specific categories defined by MIL-STD-1580, and within this specification, shall be subject to lot conformance evaluation through the use of a DPA. When a specific DPA requirement/procedure is not present, the Project Parts Engineer shall define a procedure for the evaluation of the devices, and submit it to the Parts Control Board for documentation and approval.

5 Packaging and Shipping

5.1 Packaging. DPA sample remains shall be packaged in such a manner as to prevent uncontrolled degradation or additional damage to the samples, from electrical, mechanical, environmental, and physical damage, during common carrier transportation to the procuring activity.

6 Notes

6.1 ESD Handling Precautions. ESD handling precautions in accordance with ESD S20.20, shall be followed to the greatest extent practical, such that damage to the supplied samples is not induced during the DPA processing.

Appendix A

PIND Procedure for Relays

APPENDIX B

PARTICLE IMPACT NOISE DETECTION (PIND)

10. SCOPE

10.1 Scope. The purpose of this test is to detect the presence of free moving particulate contaminants within sealed cavity devices. This test method is specifically directed toward relays and other devices where internal mechanism noise makes rejection exclusively by threshold level impractical. The test provides a nondestructive means of identifying those devices containing particles of sufficient mass that, upon impact with the case, excite the transducer. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS This section is not applicable to this appendix.

30. EQUIPMENT

30.1 Equipment. The equipment required for the particle impact noise detection (PIND) test shall consist of the following (or equivalent). PIND instruments are available which incorporate items a - h (see figure 11).

a An oscilloscope capable of 500 kHz response minimum, and a sensitivity of 20 mV/cm for visual display of the particle noise.

b An audio system with speaker to monitor the audio signal from the PIND electronics. If headphones are used, the system shall provide safeguards against loud noise bursts.

c. A vibration shaker and driver assembly to accommodate the weight of the payload. The payload consists of the DUT (device under test), (PIND) transducer, the transducer isolator, preamplifier (when included), co-test shock mechanism (when included), a portion of the transducer cable and its restraints. The shaker and driver assembly shall be capable of providing essentially sinusoidal motion at.

(1) Condition A. 5g peak at 27 Hz in 3 axes.

(2) Condition B: 5g peak at 27, 40, and 100 Hz in optimum axis.

d. PIND transducer, calibrated to a peak sensitivity of -77.5 ±3 dB at 1 volt per microbar at a point within the frequency range of 150 - 160 kHz.

e. A sensitivity test unit (STU) (see figure 11) for periodic assessment of the PIND system performance. The STU shall consist of a transducer with the same tolerances as the PIND transducer and a circuit to excite the transducer with a 250-microvolt ±20 percent pulse. The STU shall produce a pulse of about 20 mV peak on the oscilloscope when the transducer is coupled to the PIND transducer with attachment medium.

f. PIND electronics, consisting of an amplifier with a gain of +60 ±2 dB centered at the frequency of peak sensitivity of the PIND transducer to amplify the transducer signal to a usable level for audio detection and oscilloscope display. The noise at the output of the amplifier shall not exceed 10 mV peak

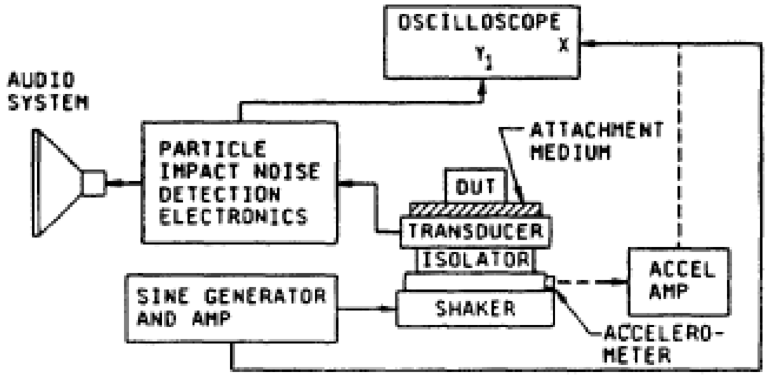
g. Co-test shock mechanism consisting of the integral co-test shock mechanism of 30.1c above (when included) capable of imparting shock pulses of at least 200g peak to the DUT, and shall be capable of providing a pulse duration not exceeding 1 ms. If the integral co-test shock system is used, the shaker vibration may be interrupted or perturbed for a period of time not to exceed 250 ms from initiation of the shock pulse.

NOTE: When co-test shock capabilities are not available, the DUT shall be pre-shocked in accordance with 40 4.1b

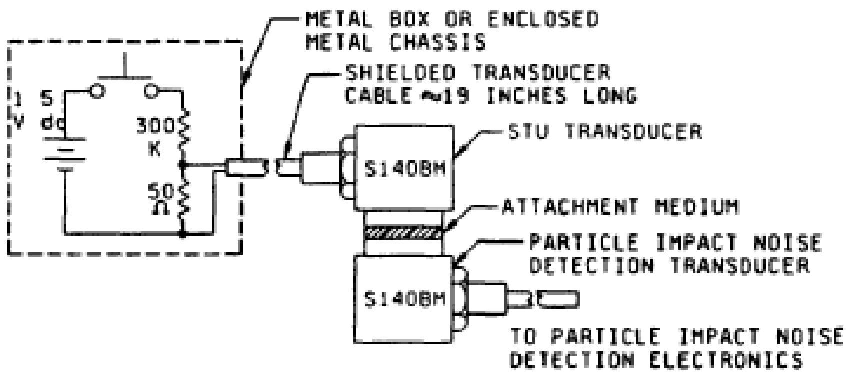
h Isolator material between the PIND transducer and the vibration shaker and driver when required to reduce background noise. The isolator shall have no resonance within the test frequency range.

i. Attachment medium. The attachment medium used to attach the DUT to the PIND transducer shall be either a viscous acoustic couplant or double-faced tape. A mechanical holding fixture that can be shown to produce no noise signature may also be used, in conjunction with acoustical couplant (if necessary) for large packages.

j. Special mounting adapters for devices which have irregular surfaces (see 40.4.1)



Typical particle impact noise detection system



Typical sensitivity test unit

NOTES:

1. Pushbutton switch: Mechanically quiet, fast make, gold contacts. E.G. T2 SM4 microswitch.
2. Resistance tolerance 5 percent noninductive.
3. Voltage source can be a standard dry cell.
4. The coupled transducers must be coaxial during test.
5. Voltage output to STU transducer 250 microvolts, ±20 percent
6. A function generator with a 250 microvolt ±20 percent square wave output at 150 kHz nominal with 50 ohms output impedance may be substituted for enclosed metal chassis.

FIGURE 11. Typical particle impact noise detection system and sensitivity test unit.

APPENDIX B

40. PROCEDURE

40.1 Test equipment setup. The test equipment shall be set up in a low noise area. Noise in this context refers not only to that audible noise which would normally interfere with listening but also power line noise, radiated R.F. noise or high frequency acoustic noise (150 - 160 kHz). Commercial equipment shall be connected as described in the operations manual. Otherwise, assembled PIND equipment shall be connected as shown on figure 11.

a. Audio output volume shall be adjusted to a comfortable noise level output.

b. Shaker drive frequency shall be adjusted in accordance with 40.3.

c. Shaker drive amplitude shall be adjusted in accordance with 40.3 and mounting adapter (if any) shall be in place.

d. Oscilloscope vertical deflection primary beam sensitivity (displaying PIND electronics output) shall be 20 millivolts/centimeter Oscilloscope horizontal deflection shall be adjusted to 4 cm and shall * obtain drive from the sine generator/amplifier accelerometer, or a time base (2 ms/cm) triggered from the accelerometer output.

40.2 Test equipment checkout. The test equipment checkout shall be performed daily or prior to the start of, and at the completion of, daily PIND testing with results recorded. Failure of the system to meet checkout requirements shall require retest of all devices tested subsequent to the last successful system checkout.

40.2.1 Shaker drive system checkout. The drive system shall achieve the shaker frequency and the shaker amplitude specified in 40.3. The drive system shall be calibrated so that the frequency settings are within ±8 percent and the amplitude vibration settings are within ±10 percent of the nominal values. If a visual displacement monitor is affixed to the transducer, it may be used for amplitudes between .04 and .12 inch (1.02 and 3 05 mm). An accelerometer may be used over the entire range of amplitudes and shall be used below amplitudes of 040 inch (1.02 mm).

40.2.2 Detection system checkout. With the shaker de-energized, the STU transducer shall be mounted face-to-face and coaxial with the PIND transducer using the recommended attachment medium. The STU shall be activated several times to verify low level signal pulses visually on the oscilloscope (approximately 20 mV peak or 10 mV peak above system noise). If a commercial instrument is used, follow the manufacturer's detection system checkout procedure. With the approval of the qualifying activity, an alternate calibrated noise generator may be used to perform the system checkout. In this case, the calibrated generator is tested in accordance with this procedure to demonstrate that oscilloscope traces are achieved to result in rejection.

NOTE: Not every application of the STU will produce the required amplitude but the majority of applications will do so.

40.2.3 System noise verification. For proper system operation, no extraneous noise can be permitted to exist in the system. During proper operation, the normal system noise, as observed on the oscilloscope, will appear as a fairly constant band and must not exceed 10 mV zero to peak. Extraneous noise is defined as noise in the system other than the permissible background noise that is present with no device on the transducer. Such noise can be due to a number of sources which must be eliminated or their effects guarded against, since those non-signal noise spikes can appear as signals on the indicators. Common sources of noise are fluorescent lighting, heater elements, soldering irons and other switching transients, line transients and, especially, less than optimum installation and support of the transducer cabling. The latter source normally may be eliminated by redressing the cable, tightening or cleaning the connector at the transducer, or even replacing the transducer or transducer cable. To verify that no extraneous noise exists in the system, observe the oscilloscope while turning on the shaker at the designated frequency and amplitude. This noise is usually present as pulses which remain in a fixed position on the oscilloscope trace If extraneous noise is observed, correct the problem by shielding or other precautions, such as those suggested above and re-run the entire noise check.

Acceptance criteria: Each unit tested shall meet the acceptance.

Shaker noise: Timebase adjusted to locate shaker reversal noise bursts at end of oscilloscope trace. Test unit not mounted.

a

Inherent mechanical noise Synchronized spike may appear at different locations on timebase for each unit under test.

b

Particulate noise: Nonsynchronized spikes of any magnitude appear randomly and may disappear as test progresses Unit is rejectable

c

Excessive mechanical noise:

Synchronized trace masks more than 50 percent of oscilloscope trace. Unit is rejectable.

d

FIGURE 12. Representative oscilloscope traces

40.3 Test parameters. The following test parameters shall be applied to each DUT. If it has been demonstrated that one or more of these parameters are damaging to a given part type, the test shall be performed as defined by the parts detailed specification. Test parameters shall be documented in the report.

40.3.1 Vibration frequency:

Condition A: 27 Hz, three axes.

Condition B: 27 Hz, 40 Hz, and 100 Hz, optimum axis.

40.3.2 Vibration amplitude. Conditions A and B: 5g.

40.3.3 Shock level. Conditions A and B: 200g peak, 1 ms, maximum.

40.4 Test sequence. The condition A or B (as applicable) test sequence shall be applied to each DUT as follows:

40.4.1 Condition A sequence.

a. Vibration 5 seconds at 27 Hz.

b. Co-test shock (three pulses).

NOTE: When co-test shock capability does not exist, the DUT shall be preshocked with 2 pulses in each of 3 axes at 200g peak, 1 ms (maximum), using equipment and techniques as defined by method 213 of MIL-STD-202, and step 40 4.1b. may be omitted.

c. Vibration 5 seconds at 27 Hz.

d. Repeat test in the two other orthogonal axes.

e. Accept or reject.

40.4.2 Condition B sequence. Apply 40.4 1, steps a, b, and c to the DUT in its optimum axis as defined by the detailed specification. Repeat the test at 40 Hz and 100 Hz. Accept or reject.

40.5 Mounting requirements. For condition A, the DUT shall be mounted such that it is ultimately tested in three orthogonal axes, one of which represents the normal mounting configuration for the device For condition B, the DUT shall be mounted in the optimum axis as specified by the detail specification for minimizing inherent device noise. When special fixturing is required for unusual package configurations, such fixtures shall have the following properties.

a. Low mass.

b. High acoustic transmission (aluminum alloy 7075 works well).

c. Full transducer surface contact, especially at the center.

d. Maximum practical surface contact with test part.

e. No moving parts.

f. Suitable for attachment medium mounting.

Leads on the parts shall be dressed, as necessary, so they will not strike each other or the transducer during vibration. Long or thin cross section leads shall be observed for signs of resonance, indicated by motion exceeding 3 or 4 diameters. Such resonance may give extraneous noise during test even though the leads do not strike each other In these cases, the leads may have to be shortened (if permitted by the application) or special fixturing or frequency changes may be required

40.6 Test monitoring. To avoid false indications, the DUT shall be inspected for any attached foreign matter or leads which are touching each other. The DUT shall be mounted on the center of the transducer using attachment medium or, if necessary, a mounting adapter or holding fixture. To provide maximum signal transmissibility with a viscous couplant, a sufficient amount of couplant shall be used and the DUT shall be firmly mounted so that any excess couplant can be squeezed out. When double-faced tape is used, it shall be changed at the start of a test group and after 25 units or less thereafter. Devices shall be put on and removed from the attachment medium with a slight twisting motion. Device orientation for each package type shall be as specified in 40.5. The vibration frequency and the vibration amplitude shall be set at the level specified in 40.3. Both detection systems shall be monitored for evidence of loose particles. Any device which gives a particle indication shall be considered a reject. Particle indications can occur in either detection system as follows:

a. Visual indication of high frequency spikes which exceed the normal constant background white noise level and the DUT inherent noise level.

NOTE: The repeatable periodic inherent noise signature of electromechanical devices must be fully characterized to avoid false indications of failure and to avoid the masking of particles (see figure 11).

b Audio indication of clicks, pops, or rattling which is different from the noise signature of the DUT or the constant background noise present with no DUT on the transducer.

c If there is no indication of particles prior to co-test shock or 5 seconds after co-test shock, the device is acceptable. When pre-shock is used in place of co-test shock, there shall be no particle indications during the 10 seconds of vibration

40.7 Co-test shock application (when applicable) The operation of the co-test shock mechanism shall be in accordance with procedures supplied by the equipment manufacturer. In systems that disable the detector during the co-test shock, the period of time from shock pulse to reinitiation of detection shall not exceed 100 ms.

40.8 Additional test cycles. If additional cycles of testing on a lot are specified, the entire test procedure (equipment set-up and checkout mounting, vibration, and co-shocking) shall be repeated for each retest cycle. Reject devices from each test cycle shall be removed from the lot and shall not be retested in subsequent lot testing.

40 9 Failure criteria. Any noise bursts as detected by either of the two detection systems (see 40.6) exclusive of DUT inherent noise or background noise during the monitoring periods shall be cause for rejection of the device. Rejects shall not be retested, except for retest of all devices in the event of test system failure as provided for 40.2.

50. SUMMARY

50.1 Summary. The following details shall be specified in the applicable detail specification or procurement documentation.

a. Lot acceptance/rejection criteria (if applicable)

b Vibration, conditions A or B

NOTE Unless otherwise specified, condition A shall apply When condition B is required, the optimum (required) axis of vibration shall be specified

c Co-test shock level and duration, if other than as defined herein.