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

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DESTRUCTIVE PHYSICAL ANALYSIS (DPA)  
OF EEE PARTS

GSFC S-311-M-70

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SECTION 1

SCOPE

1.1 PURPOSE

The purpose of this document is to describe the general requirements for performance of destructive physical analysis (DPA) on samples of parts. This specification will identify the tests to be performed and the appropriate acceptance/rejection criteria to be used in the testing of electronic, electromagnetic, and electromechanical parts. The appendices in the back of this document are provided to give further guidance in the performance of destructive physical analysis.

1.2 APPLICATION

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

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Section 2

APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents, of the issue in effect on the date of the invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

2.2 STANDARDS

MILITARY:

MIL-STD-105	SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY ATTRIBUTES
MIL-STD-202	TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS
MIL-STD-750	TEST METHODS FOR SEMICONDUCTOR DEVICES
MIL-STD-883	TEST METHODS AND PROCEDURES FOR MICROELECTRONICS
MIL-STD-1580	DESTRUCTIVE PHYSICAL ANALYSIS FOR ELECTRONIC, ELECTROMAGNETIC, AND ELECTROMECHANICAL PARTS
DOD-STD-1686	ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS ASSEMBLIES AND EQUIPMENT.

2.3 OTHER DOCUMENTS

NASA:

SPAR	GUIDELINES FOR STANDARD PAYLOAD ASSURANCE REQUIREMENTS FOR GSFC ORBITAL PROJECTS
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GSFC PPL	GSFC PREFERRED PARTS LIST
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NATIONAL BUREAU OF STANDARDS:

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NBS SPECIAL NOTES ON SEM EXAMINATION OF  
PUBLICATION 400-35 MICROELECTRONIC DEVICES

#### 2.4 ORDER OF PRECEDENCE

In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence. In the event of a conflict between this standard and a procurement specification, the procurement specification shall take precedence. However, nothing in this standard shall supersede applicable laws and regulations unless a specific exemption has been obtained.

SECTION 3

DEFINITIONS

3.1 DEFECT

A defect is any nonconformance from specified requirements which affects form, fit, or function.

3.2 DESTRUCTIVE PHYSICAL ANALYSIS

A destructive physical analysis (DPA) is a systematic, logical, detailed examination of parts during various stages of physical disassembly, conducted on a sample of completed parts of a given lot, wherein parts are examined for a wide variety of design, workmanship, and processing problems that may not show up during normal screening tests. The purpose of these analyses is to determine those lots of parts, delivered by a vendor, which have anomalies or defects such that they could, at some later date, cause a degradation or catastrophic failure of a system.

3.3 LOT RELATED DEFECT

A lot related defect is an anomaly attributable to a variance in the design, manufacturing, test, or inspection process that is repetitive throughout a production lot.

3.4 PRODUCTION LOT

A production lot is a group of parts defined by the part specification or drawing, and identified with a lot date code.

3.5 SCREENABLE DEFECT

A screenable defect is one for which an effective, nondestructive screening test or inspection can be reasonably developed and applied to eliminate, with confidence, the nonconforming items from the lot.

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SECTION 4

GENERAL REQUIREMENTS

The general requirements of this specification are the same as those requirements outlined in MIL-STD-1580(USAF) Section 4.

In determining the level of testing and inspection methods, refer to the procurement document to verify the class of the part purchased. If no class has been specified in the procurement document then class B or equivalent class is to be assumed and parts are to be subjected to class B level of testing and inspection methods.

Change in the order in which tests are performed is permitted with prior approval from the governing activity.

Sampling is to be performed in accordance with paragraph 4.1 of MIL-STD-1580(USAF) or with the sampling plan specified in the applicable procurement document; the plan specified in the procurement document shall take precedence over other plans. Lots of 200 or less shall be sampled as outline in Table 1. Table 1 indicates the required number of samples to be subjected to destructive physical analysis per lot date code (LDC). If identical parts are received with different lot date codes, the parts will be separated by lot date codes and subjected to the sampling plan of Table 1.

Small Lot Sampling Plan

<u>Lot Size per LDC</u>	<u>Sample Size</u>
<5	1
5-15	2
16-50	3
>50	5

Table 1. Sample size for number of parts per lot date code.

SECTION 5

DETAILED REQUIREMENTS

This section calls out the detailed requirements for destructive physical analysis of commonly used components. These requirements supplement the general requirements of section 4. Pre-DPA tests, such as functional tests and solderability tests, are assumed to have been satisfied by normal inspection and testing.

5.1 CAPACITORS

5.1.1 Capacitors, fixed ceramic  
type: MIL-C-20  
MIL-C-123  
MIL-C-39014

Follow procedure outlined in MIL-STD-1580 (USAF)  
Section 5.1.

5.1.2 Capacitors, fixed, ceramic chip  
type: MIL-C-123  
MIL-C-55681

Follow procedure outlined in MIL-STD-1580 (USAF)  
Section 5.2.

5.1.3 Capacitors, fixed mica  
type: MIL-C-87164  
MIL-C-39001

Follow procedure outlined in MIL-STD-1580 (USAF)  
Section 5.3.

5.1.4 Capacitors, fixed, solid tantalum  
type: MIL-C-39003

Follow procedure outlined in MIL-STD-1580 (USAF)  
Section 5.4.

5.1.5 Capacitors, fixed, tantalum foil  
type: MIL-C-39006

Follow procedure outlined in MIL-STD-1580 (USAF)  
Section 5.5.

5.1.6 Capacitors, fixed, paper or plastic film  
type: MIL-C-19978

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Follow procedure outlined in MIL-STD-1580(USAF)  
Section 5.6.

5.1.7 Capacitors, fixed, metallized film

type: MIL-C-87217  
MIL-C-83421

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 5.7.

5.1.8 Capacitors, fixed, tantalum slug, wet  
electrolyte

type: MIL-C-39006/22  
MIL-C-83500/01

Follow procedure outlined in MIL-STD 1580(USAF)  
Section 5.8.

5.1.9 Capacitor, fixed, glass

type: MIL-C-23269

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 5.9.

5.1.10 Capacitor, variable, piston type,  
sealed and unsealed

type: MIL-C-14409

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 5.10

## 5.2 MAGNETIC DEVICES

5.2.1 INDUCTORS and TRANSFORMERS

type: MIL-STD-981

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 10.1

5.2.2 RF COILS

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 10.2.

## 5.3 RESISTORS

5.3.1 Resistors, variable, wire wound

type: MIL-R-39015

Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.1

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- 5.3.2 Resistors, variable, nonwirewound  
type: MIL-R-39035  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.2
- 5.3.3 Resistors, metallized film  
type: MIL-R-55182  
MIL-R-39017  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.3.
- 5.3.4 Resistors, fixed, metal foil  
type: MIL-R-55182 (RNC90)  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.4.
- 5.3.5 Resistors, fixed, chip  
type: MIL-R-55342 (RM)  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.5.
- 5.3.6 Resistor networks  
type: MIL-R-83401  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.6.
- 5.3.7 Resistors, wirewound, accurate  
type: MIL-R-39005  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.7.
- 5.3.8 Resistors, fixed, wirewound, power  
type: MIL-R-39007  
MIL-R-39009  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 13.8.
- 5.3.9 Resistors, carbon composition  
type: MIL-R-39008 (RCR)  
DPA not Required

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5.4 SWITCHES

5.4.1 Switch, snap, action  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 14.1.

4.4.2 Switch, Thermal  
Follow procedure outline in MIL-STD-1580(USAF)  
Section 14.2.

5.5 THERMISTORS

5.5.1 Thermistor, glass bodied, hermetic  
type: MIL-T-23648  
Follow procedure outline in MIL-STD-1580(USAF)  
Section 15.1.

5.5.2 Thermistor, disc and bead encapsulated  
type: MIL-T-23648  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 15.2

5.6 CRYSTALS

5.6.1 Crystal units, Quartz  
type: MIL-C-3098  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 7.1.

5.7 CONNECTORS

5.7.1 Connectors, multipin, excluding contacts  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 6.1.

5.7.2 Connectors, multipin, with contacts  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 6.2

5.7.3 Connectors, RF  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 6.3.

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5.7.4 Connector, contacts  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 6.4.

5.8 FILTERS

5.8.1 Filters, EMI, low pass, feed through  
type: MIL-F-28861  
MIL-F-15733  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 9.1.

5.9 RELAYS

5.9.1 Relays  
type: MIL-R-6106  
MIL-R-39016  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 12.1.

5.10 DIODES

5.10.1 Diodes  
type: MIL-S-19500  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 8.1. After electrical testing, devices  
constructed with an internal cavity shall be  
subjected to PIND testing in accordance with MIL-  
STD-883 method 2020.

5.11 TRANSISTORS

5.11.1 Transistors  
type: MIL-S-19500  
Follow procedure outlined in MIL-STD-1580(USAF)  
Section 16.1. After electrical testing, devices  
constructed with an internal cavity shall be  
subjected to PIND testing in accordance with MIL-  
STD-883 method 2020.

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5.12 MICROCIRCUITS

5.12.1 Microcircuits, hybrid

Follow procedure outlined in MIL-STD-883  
Method 5009.1 para. 3.5

5.12.2 Microcircuits, multichip

Follow procedure outlined in MIL-STD-883  
Method 5009.1 para. 3.5

5.12.3 Microcircuits, monolithic

Follow procedure outlined in MIL-STD-883  
Method 5009.1 para. 3.4.

Additional testing for non-standard parts  
to be done in accordance with GSFC PPL Table 10:  
PIND MIL-STD-883 method 2020

APPENDIX A

RADIOGRAPHIC EXAMINATIONS

1. Radiographic examinations may be performed as an extension to normal DPA procedures for the purpose of determining defects which may be present within a component prior to opening that component. The following specifications or approved equivalent shall be used when performing radiographic examinations:

Integrated circuits	MIL-STD-883	method 2012
Transistors, Diodes	MIL-STD-750	method 2076
Passive Devices	MIL-STD-202	method 209

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APPENDIX B

ENERGY DISPERSIVE X-RAY ANALYSIS

The purpose of this test is to help in the identification of certain defects or anomalies which may be present in a component. Energy dispersive X-ray analysis (EDXA) is used to determine the elemental makeup of a selected particle or item within a component. EDXA may be performed at the same time that SEM examinations are being performed. Actual operation of the EDXA unit shall be in accordance with manufacturer instructions and shall be performed by a properly trained operator. Results of this analysis shall be recorded and maintained with the results of SEM examination.

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APPENDIX C

SCANNING ELECTRON MICROSCOPE (SEM)  
EXAMINATION

The SEM examination is used as a compliment to the optical microscope during the internal examination process of a DPA procedure. It is used to look at wire bonds, metallization integrity, chip bonds, particles, oxide faults, or laser trim faults. The following Military Standards or approved equivalent procedures may be used to perform SEM examinations:

Semiconductors	MIL-STD-750	method 2077
Integrated circuits	MIL-STD-883	method 2018