MIL-STD-415D
1 OCTOBER 1969
SUPERSEDING
MIL-STD-00415C (USAF)
21 October 1968
MIL-STD-415B
8 February 1961

# MILITARY STANDARD

# TEST PROVISIONS FOR ELECTRONIC SYSTEMS AND ASSOCIATED EQUIPMENT, DESIGN CRITERIA FOR

FSC MISC

DEPARTMENT OF DEFENSE
WASHINGTON, D. C. 20301

TEST PROVISIONS FOR ELECTRONIC SYSTEMS AND ASSOCIATED EQUIPMENT, DESIGN CRITERIA FOR

MIL-STD-415D

1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.

2. Recommended changes, additions, or deletions should be addressed to Commander, Aeronautical Systems Division, Attn: ASNPS-20, Wright-Patterson Air Force Base, Ohio 45433.

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# TEST PROVISIONS FOR ELECTRONIC SYSTEMS AND ASSOCIATED EQUIPMENT, DESIGN CRITERIA FOR

## 1. SCOPE

1.1 Coverage.- This standard establishes design criteria for test provisions that permit the functional and static parameters of electronic systems and associated equipment to be monitored, evaluated, or isolated. These test provisions consist of the following:

(a) An external test receptacle for connecting automatic, semi-automatic, or manual checkout equipment or automatic monitoring equipment (see 5.2.2).

(b) A built-in test capability (see 5.2.3).

(c) Test points (see 5.2.4).

1.2 Purpose.- The purpose of this standard is to provide test provisions that will adequately support a defined maintenance concept.

1.3 Classification of test provisions.- For the purpose of this standard, test provisions are classified by the item level of maintenance they are to support. Some provisions may support more than one maintenance level.

1.3.1 Class A test provisions.- Class A test provisions evaluate item performance of the equipment. This class provides the means to determine if the equipment is functioning within the performance limits specified in the specification.

1.3.2 Class B test provisions.- Class B test provisions isolate malfunctions to a replaceable unit. (RU).

1.3.3 Class C test provisions.- Class C test provisions isolate malfunctions to a replaceable module (RM) or other replaceable assembly.

1.3.4 Class D test provisions.- Class D test provisions consist of test points (jacks, terminal boards, circuit junctions, and so forth) that isolate malfunctions of modules or other replaceable assemblies that have fixed circuitry (such as printed circuits, circuit cards, assemblies, and so forth) to an individual circuit and piece part level.

## 2. REFERENCED DOCUMENTS

2.1 The following document, of the issue in effect on date of invitation for bids or request for proposal, forms a part of this standard to the extent specified herein:

MIL-STD-1472 Human Engineering Design Criteria for Military Systems, Equipment and Facilities

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

## 3. DEFINITIONS

3.1 The terms used in this standard are defined as follows:

(a) Test provisions: The capability for evaluating the performance of and testing the prime equipment unit, module, assembly or part.

(b) Item: A nonspecific term used to denote any unit or product including materials, parts, subassemblies, equipments, accessories and attachments.

(c) Automatic test equipment (ATE): An equipment that is designed to automatically conduct analysis of functional or static parameters, evaluate the degree of performance degradation and perform fault isolation of item malfunctions.

(1) Automatic monitoring equipment (AME): An equipment that is designed to automatically conduct analysis of functional or degradation.

(2) Automatic checkout equipment (ACE): An equipment designed to check functional parameters and to perform fault isolation of item malfunctions.

(d) Test point: A convenient and safe access to a single point in a circuit or mechanism used to measure or inject a significant quantity for the purpose of evaluating or troubleshooting the circuit mechanisms.

(e) Replaceable unit (RU): Any unit that is designed and packaged to be readily removed and replaced in an equipment system without unnecessary calibration or adjustment.

(f) Replaceable module (RM): An item that is designed and packaged in an RU for ready removal and replacement.

(g) GO-NO-GO testing: A set of terms (in colloquial usage) referring to the condition or state of operability of a component or system which can have only two parameters, "GO" functioning properly, or "NO-GO", not functioning properly. An indicator shall be provided.

(1) Presence tests: Presence tests verify the presence, or absence, of item signals or characteristics. Such signals or characteristics are those which are not tolerance critical to operation of the item.

(2) Comparative tests: Comparative tests compare item signal or characteristic values with a specified tolerance band and present the operator with a GO-NO-GO readout; a "GO" for signals within tolerances, and a "NO-GO" for signals out of tolerance.

(h) Marginal testing: Testing that presents results on an indicator that has tolerance bands for evaluating the signal or characteristic being tested. (For example: a green band might indicate an acceptable tolerance range; a yellow band, a tolerance range representing marginal operation; and a red band, a tolerance that is unsatisfactory for operation of the item.)

(i) Quantitative testing: Testing that monitors or measures the specific quantity, level, or amplitude of a characteristic to evaluate the operation of an item. The output of such tests are presented as finite or quantitative values of the associated characteristics.

4. GENERAL REQUIREMENTS

4.1 Applicability of standard.- The requirements of this standard shall apply to the extent specified by the referencing specification or the contract.

4.2 Analysis.- The contractor shall analyze the item design to determine the test provisions that are required for operation and maintenance. The type, amount, and configuration of test provisions shall be compatible with the item maintenance concept approved by the procuring activity. When the contract requires a guidance meeting the analysis shall also be governed by the decisions made as a result of the meeting.

4.2.1 The contractor shall consider all levels at which the item is to be maintained, such as organizational (flight line/on-board/on-site), intermediate, or depot levels of maintenance. In determining the test provisions to be provided, the contractor shall take into account the environments in which the item is to be maintained and the skill levels of the personnel who will use the test provisions. He shall insure that all significant factors affecting maintenance of the item are considered. Inherent self-test capabilities shall be considered. The contractor shall insure a minimum of duplication in the capabilities of test provisions ultimately decided upon.

4.3 Quality assurance.- Test provisions shall meet as a minimum the same design requirements and quality assurance provisions specified in the applicable specification for the item of which they are a part.

5. DETAIL REQUIREMENTS

5.1 Design.- Test provisions shall be provided in items to facilitate performance evaluation, malfunction detection and correction, and maintenance. The specific test provisions to be designed as part of the item shall depend upon the operational and maintenance demands placed on the item by the maintenance concept, and included in the item specification. The design of test provisions shall assure that their operation is simple, fool proof, and fail safe. Their complexity shall be minimized, consistent with the achievement of the requirements specified in the item specification and this standard.

5.2 Test capabilities.- Test provisions shall adhere to the general design of 5.2.1, and shall include one or more of the test capabilities specified in 5.2.2, 5.2.3 and 5.2.4, as defined by the maintenance concept.

5.2.1 General design considerations.-

5.2.1.1 Accuracy.- The design of test provisions shall permit accurate, decisive, and repeatable measurements of item characteristics and parameters. The accuracy of testing or sensing circuitry shall exceed that of the characteristic or parameter being tested or sensed to insure the effective implementation of the maintenance concept.

5.2.1.2 Maintainability.- Test provisions shall be such that their maintainability is consistent with the maintenance designed concept and the maintenance requirements of the equipments into which the test provisions have been incorporated.

5.2.1.2.1 To the maximum extent practicable, modular construction shall be used. The arrangement and mounting of parts shall be such that test provision malfunctions can be readily isolated and the cause of the malfunction corrected by simple replacement of modules or parts.

5.2.1.2.2 Accessibility of test provisions shall be consistent with the requirements of 1.3.

5.2.1.3 Degradation and damage.- The design or use of test provisions shall not degrade the required performance of the item in which they are contained. The provisions shall also be provided with adequate overload or decoupling protection to insure that the provisions are not damaged by item signals or characteristics which may exceed specified tolerances.

5.2.1.4 Electromagnetic interferance (EMI).- Test provisions shall meet the EMI requirements of the item specification.

5.2.1.5 Weight and space.-

5.2.1.5.1 The selection of parts and design of test provisions shall be such that the provisions are incorporated in the item with a minimum addition of weight and space and consistent with other design constraints. The contractor shall make maxiuum use of state-of-the-art miniaturized components and miniaturization techniques. When integrated circuit design is practical, it shall be employed to the maximum extent possible.

5.2.1.5.2 Unless a deviation is obtained from the procuring activity, the weight of test provisions incorporated in airborne equipment shall not exceed three percent of the weight of the item in which it is contained.

5.2.2 Automatic checkout and automatic monitoring capabilities.-

5.2.2.1 Automatic checkout capability.- The automatic checkout capability shall permit automatic checkout equipment (ACE) to conduct analysis of functional parameters of an item to evaluate performance and to determine location of a malfunction.

5.2.2.1.1 Applicability of test provision classes.- Class A, B, C, and D test provisions shall be applicable to the automatic checkout capability.

5.2.2.2 On-board/on-site automatic monitoring capability.- The on-board/on-site automatic monitoring capability shall permit automatic monitoring equipment (AME) to conduct analysis of functional or static parameters of an item to evaluate the degree of performance degradation and to determine location of a malfunction.

5.2.2.2.1 Applicability of test provision classes.- Class A, B, and C test provisions shall be applicable to the on-board/on-site automatic monitoring capability.

5.2.2.3 External receptacle(s).- Automatic checkout or automatic monitoring of an item shall be accomplished by the availability of an accessible electrical receptacle(s) that is flush mounted on the item. The electrical receptacle(s) for automatic checkout and monitoring shall be readily accessible for connection to ACE and AME. When ACE receptacles are available on the item, AME shall make maximum use of these receptacles.

5.2.2.3.1 The external receptacle(s) will be utilized by either automatic, semi-automatic, or manual checkout equipment.

5.2.2.3.2 The external receptacle(s) shall be provided to facilitate the automatic checkout capability or the automatic monitoring capability, even though a built-in test capability or test points exist in the design of the item.

5.2.2.3.3 The arrangement of receptacle(s) shall provide maximum utilization of the space available on the accessible surface of the item. Where multiple receptacles are used, the space between such receptacles shall not be less than 1 inch. Receptacles shall be of the quick disconnect type.

5.2.3 BIT capability.- The built-in-test (BIT) capability shall be incorporated as required by the contract to assure effective implementation of the defined maintenance concept. The built-in-test capability shall consist of the following:

(a) Self-test provisions: Self-test provisions shall be an inherent part of an item. These provisions shall serve a dual function: item performance evaluation, and complementing BIT provisions to provide item testing. When self-test provisions are practical, the contractor shall use them; however, their use shall not jeopardize the operation or performance of the item.

(b) Marginal testing: When critical item parameters or characteristics are subject to change or drift and BIT capabilities must be used, these areas shall be tested by marginal testing techniques as defined in this standard.

5.2.3.1 Applicability of test provision classes.- Class A and B test provisions shall be applicable to the BIT capability.

5.2.3.2 BIT provisions.- BIT provisions shall be added to an item for the sole purpose of testing the item. They shall be simple in design and operation, accurate, easily maintained, preferably more reliable than the circuitry providing performance, and shall not degrade the performance of the item in which they are incorporated.

5.2.3.3 Ease of operation.- BIT provisions shall provide optimum convenience of use and operation. The design of controls and read-out devices shall be such that they can be easily used and interpreted by low skill personnel. To the maximum extent it shall be possible to operate the provisions with minimum reference to item handbooks. The need for external equipment or tools to supplement this testing capability shall be minimized.

5.2.4 Test points.-

5.2.4.1 Designation.- Test points shall be provided for item parameters and characteristics which require testing and are not tested by other test provisions. The number of test points shall be kept to a minimum but sufficient to provide the scope of maintenance required of them.

5.2.4.2 Quantitative testing.- To the maximum extent practical, test points shall be used to perform quantitative testing as defined by this document.

5.2.4.3 External test points.- When the maintenance concept or contract directs external test points be provided, they will be limited to fulfilling the class A and B test provision requirements of this document and shall be located at a readily accessible surface of the item. The test points shall provide for the connection of electrical or mechanical external measuring or stimuli equipments. Unless otherwise specified by the procuring activity, electrical test points shall be of the jack type design.

5.2.4.4 Internal test points.- Internal test points shall be limited to fulfilling the class C and D test provision requirements of this document and shall be located within the item. These test points shall provide for the connection of electrical or mechanical measuring or stimuli equipments. Class C electrical test points shall be of the "stand-off" terminal type. Class D electrical test points shall preferably be of the stand-off type, but when circuit junctions are readily accessible for connection of the above specified equipments, the junction may be considered as a test point.

5.2.4.5 Mechanical test points.- When characteristics of the item are to be tested by mechanical means or the item is to be provided with mechanical inputs, the associated mechanical test points shall be designed to utilize general purpose devices or tools to the maximum extent possible. In no case, however, shall the design of the required testing capability be degraded to utilize existing equipment.

5.3 Human engineering requirements.- Human engineering design criteria and principles shall be so applied in the design of test provisions that safe, reliable, and effective performance by operator and maintenance personnel is achieved and personnel skill requirements and training time are minimized. The design of test provisions shall conform with the applicable detailed human engineering criteria established in MIL-STD-1472.

5.3.1 High voltage hazard.- When operation or maintenance of an item employing potentials in excess of 300 volts requires that these voltages be measured, the item shall be provided with test provisions so that these voltages may be measured at potential levels of less than 300 volts relative to ground. The above voltages shall be construed as applying to direct current (dc), alternating current (ac), and dc plus ac voltages.

5.3.2 Marking and color coding.-

5.3.2.1 Marking of test points.- All test points shall be permanently labeled to provide the clearest designation possible, both in terms of identification and legibility. Particular attention shall be given to the environmental conditions under which the test point must be identified in the equipment installation. Where space permits, a complete word description of the test point shall be provided. Otherwise, carefully chosen abbreviations or reference characters may be used. If possible, the within-tolerance range to be measured at the test point shall be included in the label. Waterproof ink shall not be considered as a permanent marking unless suitably protected against all environments to which it will be exposed.

5.3.2.1.1 Multiple test points.- When sequential testing is required, test points shall be grouped in a line or matrix reflecting the sequency of tests to be made. An outlined matrix array of test points shall also be used when multiple test points are associated with a single system. Each test point shall be assigned an alpha-numeric designation and appropriately referenced in the applicable maintenance instructions.

5.3.2.2 Marking of meters.- Meters shall be so marked that they may be read with ease, accuracy, and speed; and when a voltage or current is to be held within limits corresponding to a given sector of the meter scale, that sector shall be clearly marked for ease of observation. Meters used in conjunction with selector switch mechanisms shall be similarly labeled according to space limitations on the meter face. Otherwise, the subsystem or circuit designation and within-tolerance range shall be specified at each switch position.

5.3.2.3 Color coding of test points.-

5.3.2.3.1 All external test points shall be color coded to provide an indication of the type of signal to be obtained at that point. The following shall be the minimum color coding required:

| | | |
|---|---|---|
| (a) | Less than 120 volts ac: | White |
| (b) | 120 volts ac and above: | White encircled with red |
| (c) | Less than 28 volts dc: | Red |
| (d) | 28 volts dc and above: | Red encircled with red |
| (e) | Chassis ground: | Black |
| (f) | Reference ground other than chassis ground: | Gray |

NOTE: Encirclement denotes danger.

5.3.2.3.2 Additional color coding of test points shall be as delineated in the applicable specification.

6. NOTES

6.1 Intended use.- This document is intended for use by the project engineer and the procuring activity to establish test provision requirements for the item.

6.2 Ordering data.- To implement the requirements of this standard, contractual documents should include the following:

(a) Guidance meeting: A meeting between the contractor and the procuring activity to provide the contractor with system or equipment and AGE guidance relative to the item maintenance philosophy and required test provisions.

(b) Identification of the specific test capability and class of test provisions required.

6.3 Data preparation instructions.- Data generated by this document is not deliverable unless specified on the Contract Data Requirements List (DD Form 1423), referencing the appropriate data item description in the Military Department's Authorized Data List (ADL). The data required by this document is as follows:

6.3.1 The contractor shall prepare test provisions of the item in accordance with the following, but not limited to, described detail and format. It shall provide sufficient information to permit the reviewer to determine the type, amount, and configuration of test provisions proposed to support the item's maintenance concept. Unless specifically required by the procuring activity, the block diagram shall not go below the lowest RI or fixed circuitry requiring testing.

6.3.2 The contractor shall prepare a functional block diagram of the item, identifying item(s), nomenclature, part number with description, operational functions, test capabilities provided, and, where test provisions terminate in an electrical connector, the connector shall be identified in accordance with USAS-Y 32.16 - 1965, and their physical location shall be indicated.

6.3.3 The contractor shall also prepare additional functional block diagrams of the item (RU, RIs and essential fixed circuitry) identifying test provisions for the class levels required. This block diagram shall identify the electrical characteristics for each test parameter (functional entity) and the test termination in the test connector (receptacle) by pin number. The term "functional entity" as used in this document is intended to identify circuits required to perform a specific function such as, IF or AF amplifier, oscillator, power supply circuits, and so forth, used in checking normal or abnormal performance. In the event the functional schematic diagram is overly complicated, the contractor may be permitted to generate additional functional schematic diagrams of lower level test provisions that can be correlated with the master functional diagram.

6.3.4 The contractor shall prepare a table of information which can be directly correlated with the test provision information included on the block diagrams. The table shall include, but not be limited to, such information as listed below, when this is essential for testing purposes.

(a) Tolerance
(b) Test provision interrelationships
(c) Impedances
(d) Ground returns

(e) Loading
(f) Waveforms
(g) Test equipment required

6.3.5 The contractor shall prepare a brief theory of operation for the end item which shall be directly correlatible to the block diagrams and shall be of sufficient engineering detail to permit a clear understanding of the information incorporated in the diagrams.

Custodians:
Army - EL
Navy - SH
Air Force - 11

Reviewer activities:
Army - AV, EL
Navy - AS, EC, SH
Air Force - 13, 17, 19, 22, 82

Preparing activity:
Air Force - 11

Proj. No. MISC-0507

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| b. ADDRESS *(Street, City, State, ZIP Code)* | ☐ USER |
| | ☐ MANUFACTURER |
| | ☐ OTHER *(Specify)*: _____ |

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

| 7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional | b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional |
|---|---|
| c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional | 8. DATE OF SUBMISSION *(YYMMDD)* |
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