MILITARY STANDARD

TEST POINTS, TEST POINT SELECTION AND INTERFACE REQUIREMENTS FOR EQUIPMENTS MONITORED BY SHIPBOARD ON-LINE AUTOMATIC TEST EQUIPMENT

TO ALL HOLDERS OF MIL-STD-1326(NAVY)

1. THE FOLLOWING PAGES OF MIL-STD-1326(NAVY) HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
iii	1 April 1969	iii	15 January 1968
iv	1 April 1969	iv	15 January 1968
1	15 January 1968		Reprinted without change
2	1 April 1969	2	15 January 1968
3	1 April 1969	3	15 January 1968
4	1 April 1969	4	15 January 1968
5	1 April 1969	5	15 January 1968
6	1 April 1969	6	15 January 1968
7	1 April 1969	7	15 January 1968
8	15 January 1968		Reprinted without change

2. RETAIN THIS NOTICE AND INSERT BEFORE THE TABLE OF CONTENTS.

3. Holders of MIL-STD-1326(NAVY) will verify that page changes indicated in paragraph 1 have been entered. The notice page will be retained as a check sheet. This issuance, together with appended pages is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or cancelled.

Review activities:
Navy-SH, EC, OS
User activities:
Navy-AS

Preparing activity:
Navy - SH
(Project MISC-N569)

* U.S. GOVERNMENT PRINTING OFFICE: 1981—703-023/2744

FSC MISC

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Supersedes page iii of 15 January 1968.

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1. SCOPE

1.1 Scope.- This standard establishes the requirements for providing test points in prime equipments for monitoring by on-line automatic test equipment (ATE). It provides criteria for guidance in optimum test point selection. It defines interface and data requirements, a system of test point data generation, and procedures for submission of data disclosing the selections of these test points.

1.1.1 Application.- The requirements of this standard are applicable to the design of equipments intended to be interfaced with an ATE. This standard may also be used for the retrofit of existing equipments for ATE monitoring.

1.1.2 Intent.- It is the intent of this standard to specify the requirements of the procuring activity to achieve the following objectives:

(a) The optimum selection and placement of test points to:
  (1) Continuously monitor the performance of prime equipment.
  (2) Indicate the existence of a failure.
  (3) Facilitate rapid isolation of a failure to the line replaceable unit to effect repair by substitution of a spare, performance of realignment, etc.
(b) The planning and development of an adequate level of test logic design for the prime equipment in order that the ATE can be programmed to provide optimum monitoring of the sensor outputs, and to insure timely delivery of the end article and all of the required test point information.
(c) The definition of the types of test point signals and their dimensions that may be provided for ATE monitoring.

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

GOVERNMENTAL

SPECIFICATION
MIL-T-24309 - Technical Support Plans for Electronic Equipment.

STANDARD
MIL-STD-1309 - Definition of Terms for Automatic Electronic Test and Checkout.

PUBLICATION
NAVSHIPS 93820 - Handbook for the Prediction of Shipboard and Shore Electronic Equipment Reliability.

(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 definitions of MIL-STD-1309 apply. The following definitions are defined as related specifically to this standard.

3.1.1 ATE.- An abbreviation of the term "Automatic Test Equipment."

3.1.2 Prime equipment.- An equipment or system that is to be monitored by an ATE.

3.1.3 Sensor.- Circuitry and related hardware located within the prime equipment for the purpose of providing a suitable test signal for the ATE, isolating the prime equipment in the event of an ATE failure, and preventing unwanted RFI from being present in the sensor output.

3.1.3.1 Passive sensor.- A sensor requiring no source of power other than the signal being measured.

3.1.3.2 Active sensor.- A sensor requiring a source of power in addition to that of the signal being measured.

3.1.4 ATE test point.- A sensor output which is brought to an accessible location for connection to the ATE.

3.1.5 Circuit test point. - That point considered physically in the prime equipment, exclusive of isolation and sensing circuitry.

3.1.6 Simple test point. - A test point at which the parameter of interest is continuously present.

3.1.7 Complex test point. - A test point at which the parameter of interest is present only when stimulated or activated by means of the ATE program.

3.1.8 Virtual test point. - A point in the prime equipment about which information is known by virtue of processing information from actual ATE test points.

3.1.9 Module. - A physically independent assembly whose boundaries are determined by facile replacement as reflected by the applicable maintenance policy.

3.1.10 Functional entity. - The components within a theoretical boundary which are related to perform a specific function, that is, amplification, gating, filtering, etc.

3.1.11 On-line. - Monitoring and testing in a non-interfering manner while the prime equipment is in normal operation use.

3.1.12 Long term repeatability. - The maximum difference in output for any given identically repeated stimulus over a specified period of time with no change in test conditions.

4. GENERAL REQUIREMENTS

4.1 Purposes of test points. - ATE test point signals will be utilized to provide an indication of equipment performance and to permit fault location to the replaceable module or functional entity. They shall be compatible with the system circuitry to minimize the possible loss of performance occasioned by their use. A sufficient number of test points shall be provided to facilitate the location of the most probable type of circuit malfunctions which may be reasonably expected to occur. Consideration shall also be given to the monitoring of non-electrical parameters *such as equipment ambient temperature, ventilation, air velocity,* etc., if such measurements will materially reduce fault location time or provide advance warning of potential failures.

4.2 Information and performance degradation. - The prime equipment will be monitored while energized and in normal operation, therefore information available at test points shall not be degraded by manipulation of normal operator controls, nor shall there be any degradation of the equipment performance due to the choice of circuit test point location. In the event of a malfunction shorting an ATE test point; damage or performance degradation shall not be sustained by the prime equipment.

4.3 Grounding. - All ATE test point output signals shall be measured relative to a common prime equipment circuit ground which can also be grounded at the ATE. Due consideration shall be given to isolation, decoupling, and multiple and single point ground requirements. A common prime equipment circuit ground connection shall be provided for the ATE.

4.4 *Sensor preference.* - *Passive sensors* shall be used in preference to active sensors wherever possible. Where active sensors are used to provide information not obtainable by passive sensors, there shall be a minimal effect on the reliability of the circuit-sensor combination.

4.5 ATE input impedance. - Each ATE test point signal output shall be capable of driving a capacity load of up to 1000 picofarads in parallel with the ATE resistive load of one megohm.

4.6 Sensor calibration. - Sensors requiring calibration, initial or otherwise should be avoided (see 5.7).

4.7 Sensor repeatability. - The ATE test point signal repeatability tolerance (long term) shall be, at most, one-fourth the tolerance of required measurement accuracy.

4.8 Test point output location. All ATE test points and the prime equipment common circuit ground(s) shall be brought to an accessible multiplepin receptacle(s) mounted on or close to the prime equipment enclosure skin and providing termination suitable for cable connection to the ATE. Connector selection and pin assignment shall maintain integrity of line separation dictated by prime equipment for isolation of cross talk between RF, digital and analog, and d. c. signals.

4.9 Connectors. - Connectors shall conform to the detail or performance specifications for the original design or retrofit of existing prime equipment.

4.10 Shielding. - All sensors shall be designed so that interference caused by electromagnetic radiation is minimized through the use of good design principles and by filtering and shielding where necessary.

Electromagnetic interference requirements in detail or performance specifications for the original design or retrofit of existing prime equipment shall apply with the ATE test points unloaded or connected to the ATE.

4.11 Decoupling. - Adequate decoupling shall exist between the test point and the prime equipment so that degradation of equipment performance or introduction of extraneous signals does not occur before or after connection of the ATE.

4.12 Marking. - All test points terminating in jacks, sockets, or connectors shall be marked in a readily visible fashion, with markings conforming to the requirements specified in the detail or performance specification covering the prime equipment.

5. ATE MEASUREMENT CAPABILITY

5.1 General. - The ATE will have a capability to make the following types of measurements within the limitations specified in 5.2 through 5.6.3:

(a) D.C. voltages.
(b) Pulse parameters.
(c) Time interval.
(d) Frequency.

5.2 D.C. voltage measurements. -

5.2.1 General. The ATE will be capable of measuring d.c. voltages within the range of 0 to plus or minus 10 volts. However, to insure detection and measurement of abnormal voltages when they occur, each d.c. type sensor output shall fall within the range of 250 millivolts minimum to 6.67 volts maximum when monitoring a "normal" prime equipment signal for an overall ATE system accuracy of plus or minus 1 percent; lower voltage down to 50 mv, can be accommodated at reduced accuracy. In special cases where a "normal" sensed signal may vary from a positive value through zero to a negative value (or vice versa), a bipolar ATE measurement capability will be provided and the minimum voltage limit is waived.

5.2.2 ATE voltage ranges. - Zero to plus or minus 1.0 volt, 0 to plus or minus 3.33 volts, and 0 to plus or minus 10.0 volts.

5.2.3 ATE resolution of measurement. - One thousand digital increments per voltage range, zero to full scale (2,000 digital increments bipolar).

5.2.4 ATE input impedance. - One megohm resistive.

5.2.5 Modulation. - A.C. ripple or modulation superimposed on the d.c. signal will affect the measurement. A d.c. measurement will be in error by an amount equal to the peak amplitude of the unwanted modulation superimposed on the desired d.c. output and therefore it should be minimized.

5.2.6 Proportionality and offset. - Variation in a d.c. sensor output voltage shall be directly proportional to the variation in prime equipment signal being monitored. A d.c. offset may be present.

5.2.7 Maximum output. - The d.c. sensor output shall not exceed 12 volts in amplitude. This shall include predictable type failures of the prime equipment.

5.3. A.C. voltage measurements. -

5.3.1 Conversion. - Prime equipment a.c. voltages chosen to be monitored shall be converted by the sensor to a proportional d.c. voltage.

5.3.2 Measurement. After conversion to d.c. by the sensor, the d.c. voltage measurement specifications of 5.2 shall apply.

5.4 Pulse parameter measurements. - Pulse parameters such as: risetime, falltime, pulse width and pulse amplitude, shall be converted to a d.c. analog voltage output in accordance with the requirements of 5.2.

5.5 Time interval measurements. - Unless otherwise specified, time interval measurements shall be as specified in 5.5.1 through 5.5.5.

5.5.1 General. - Time interval measurements can be made by the ATE between successive pulses, sinusoidal, or other type periodic waves that occur in repetitive nature and are available from a single sensor. Time interval measurements between pulses on different ATE test point outputs can be made as a special requirement (see 5.7).

5.5.2 Time interval measurement capability. - From 50 nanoseconds minimum to 32.767 milliseconds maximum.

5.5.3 Amplitude limits. -

5.5.3.1 Pulse requirements. - The ATE will measure pulse time intervals on positive or negative pulses within the range of 1.5 to 6.0 volts in amplitude. A sensor peak output amplitude shall not exceed 6.0 volts relative to circuit ground. A "normal" sensor pulse output shall be within the range of 2.5 to 4.0 volts in amplitude.

5.5.3.2 Sinusoidal or other periodic wave requirements. - The periodic wave shall be centered around a zero voltage axis, 3.0 volts minimum to 12.0 volts maximum peak-to-peak amplitude. A sensor periodic wave output amplitude shall be guarded against rising above plus or minus 6.0 volts relative to circuit ground.

5.5.4 ATE measurement resolution. - The resolution of measurement is in 50 nanosecond increments up to 1.638 milliseconds; 1.0 microsecond increments from 1.638 to 32.767 milliseconds.

5.5.5 Accuracy. - The ATE resolution accuracy of time interval measurement is shown on figure 1.

5.6 Frequency measurements. - Unless otherwise specified, frequency measurements shall be as specified in 5.6.1 through 5.6.3.

5.6.1 General. - Frequency measurements are obtained by an ATE processor translation of a time interval measurement (see 5.5). Using this method the frequency of a periodic repetitive type waveform can be obtained by a time interval measurement of a single cycle, which is then converted to a corresponding frequency reading.

5.6.2 Frequency range measurement capability. - Minimum frequency 30 cycles per second. Maximum frequency 1.0 megacycle.

5.6.3 Accuracy. - The ATE resolution accuracy of frequency measurements is shown on figure 2.

5.7 Special requirements. - If, after a study of test point logic, the contractor believes that adequate fault isolation can be achieved only through the use of sensor calibration, complex test points, special ATE measurement ranges or accuracies, stimulus injection, or comparison of outputs of different sensors, the contractor may petition the procuring activity to grant a waiver of the aforementioned constraints, if it will materially benefit ATE monitoring of the prime equipment. A technical description of the proposed action shall be submitted to the procuring activity for review. The technical description shall contain a functional description and reason for the action. Data such as schematics, block diagrams, and engineering sketches depicting information necessary for an engineering evaluation of the proposed action shall be prepared and submitted as part of the technical descriptions.

5.7.1 Stimulus generator. - The contractor shall submit proposals for stimuli as needed. At the option of the procuring activity, the contractor may be required to provide or build into the prime equipment the stimuli required. The procuring activity will provide stimulus control information.

6. TEST POINT SELECTION

6.1 Philosophy. - Circuit test points shall be selected on their ability to detect and isolate faults with a maximum degree of confidence to the lowest level practical, at a minimum cost.

6.2 General test point criteria. - Circuit test point placement shall be such that the degree of automatic testing reflects the repair philosophy dictated by physical configuration of the design. Since two types of repair are possible, piece-part and module replacement, it is necessary to approach these problems differently. The following general criteria for circuit test point selection shall be applied to both piece-part and modular replacement.

6.2.1 Fail safe. - The connection to the circuit test point by any sensing circuitry necessary shall be done in such a manner that malfunction of sensing circuitry shall have minimum effect on the circuit test point; the unfeasibility of this, however, is not considered sufficient grounds for not testing a particular function.

6.2.2 Displayed signals. - In general, displayed signals over which a prime equipment operator must maintain constant cognizance may be monitored by ATE.

6.2.3 Simple test points. - Circuit test point selection shall be limited to simple test points except as specified in 5.7.

6.2.4 Use of virtual test points. - Performance monitoring and fault location at a point shall be available from a single sensor. In the event that the sensing circuitry necessary to monitor the key parameter(s) of the signal would degrade the performance of the circuit, would be difficult to install or would seriously degrade the reliability, consideration shall be given to obtaining the information at this test point through ATE evaluation of a group of interrelated test points; such a circuit test point shall be considered a virtual test point.

6.2.4.1 Justification of virtual test points. - The contractor may utilize virtual test points providing he supports their necessity by submission of an engineering analysis. This analysis shall include a written disclosure, text and supporting drawings as follows:

(a) The proposed sensing circuitry shown connected to the module or functional entity in question.
(b) Quantitative analysis showing the performance degradation, if any, incurred by insertion of the sensing circuitry.
(c) A failure rate calculation, made according to NAVSHIPS 93820 or other technique acceptable to the procuring activity showing an appreciable (at least 1.1 times) increase, if any, in failure rate of the module or functional entity when the sensing circuitry is connected and included in the calculation. Interconnecting wires or cabling necessary to bring the sensed parameter to the surface of the cabinet shall be assumed as having a failure rate of zero. The procuring activity retains the option of requiring the use of sensors incurring degraded reliability if deemed important enough for the coverage of the prime equipment.

6.2.5 External power monitoring. - A separate ATE test point, with a d.c. type output, shall be provided to monitor each equipment primary supply voltage obtained from external sources. It shall monitor presence of the voltage, not a switch position.

6.2.6 Mode monitoring. - A separate test point shall be provided to monitor each normal mode of operation or condition that can be selected by an operator. These test points shall have d.c. binary type "true/false" outputs.

6.2.7 Time interval/frequency monitoring. - Where time interval or frequency measurements are to be made requiring greater accuracy than shown on figures 1 and 2, an accessible circuit test point shall be provided for direct connection of instrumentation of the required accuracy.

6.2.8 Order of priority. - Priority should be given to the testing of functions that are most important to the operational mission, that are basic to fault diagnosis, and are least reliable, or are the least accessible.

6.3 Performance monitoring test points. - Test points shall be placed to provide information concerning the over-all performance of an entire equipment as well as major portions of the equipment.

6.3.1 Interface monitoring. - A sufficient number of circuit test points shall be provided to cover major prime equipment interface signals to insure information flow to the ATE in the event of major prime equipment failure.

6.4 Fault isolation test points. -

6.4.1 Parameter choice. - The parameter chosen for monitoring at a circuit test point should be the one that most closely represents the performance of the function of the associated module(s) or functional entities.

6.4.2 Simple test points. - In fault isolation, the test point shall be simple in the mode in which isolation is performed, except as specified in 5.7.

6.4.3 Modularized equipment. The criteria for circuit test point selection and monitoring applied to modularized equipment or to modularized portions of equipment shall be as specified in 6.4.3.1 through 6.4.3.3.

6.4.3.1 Level of isolation. - Sufficient test points shall be placed in the equipment to allow ATE fault isolation to each replaceable module.

6.4.3.2 Isolation precision. - An out of tolerance indication at a test point shall unambiguously imply a failure within the module in question when no other failure indication exists.

6.4.3.3 Unmonitored modules. - A module may go untested only if the contractor can justify the inability to use an ATE test point with data required in 6.2.4.1, and in addition shows that information concerning the status of the module cannot be determined by other sensors (virtual test point).

6.4.4 Non-modularized equipment. - The criteria for circuit test point selection applied to non-modularized equipment or to non-modularized portions of equipment shall be as specified in 6.4.4.1 through 6.4.4.3.

6.4.4.1 Level of isolation. - The contractor shall define each functional entity in accordance with 3.1.10 by solid lines drawn on the blocked schematic (see appendix). A sufficient number of ATE test points shall be placed in the equipment to allow ATE fault isolation to each functional entity.

6.4.4.2 Isolation precision. - An out of tolerance indication at a test point shall unambiguously imply a failure within the functional entity in question when no other failure indications exist.

6.4.4.3 Unmonitored functional entities. - A functional entity may go untested only if the contractor can justify the inability to use an ATE test point with data required in 6.2.4, and in addition shows that information concerning the status of the module cannot be determined by other sensors (virtual test point).

7. DELIVERABLE ITEMS

7.1 Items. - The contractor shall submit for approval the following items (6 copies) to the procuring activity by the dates specified at the guidance meeting, to allow an effective review of the test point selection:

(a) Block diagram(s) and blocked schematic(s) (see appendix).
(b) Power distribution diagram(s) (see appendix).

(c) Design outline (see appendix).
(d) Test logic flow diagram.
(e) Test logic chart (s)(see figure 3).
(f) Test point data sheet (s) (see figure 4).
(g) List of modules or functional entities not covered in (f) above, and supporting documentation as specified in 5.7 and 6.2.4.1.
(h) Other supporting data or information deemed pertinent by the contractor or procuring activity.

7.2 Test point data sheet. - A list of all ATE test points shall be prepared with the following information detailed for each test point (see example, figure 4):

(a) Test point number - A number in a simple alpha-numeric code to be composed by the contractor to identify each ATE test point.
(b) Circuit drawing number - The identification of the circuit drawing which depicts the circuit containing the related circuit test point.
(c) Connector number - The identification of the connector (see 4.8) which contains the sensed information of the ATE test point.
(d) Connector pin number - The identification of the specific pin in the connector which contains the sensed information of the ATE test point.
(e) Module or entity number - The identification number (see appendix for method of establishment) of the module or functional entity which the circuit test point locates or monitors.
(f) Circuit test point - The precise description of the location of the circuit test point within the prime equipment circuitry, that is, junction of R112 and C62.
(g) Parameter measured - The statement of the key parameter, selected as specified in 6.4.1 to be monitored at the circuit test point.
(h) Parameter characteristics - The nominal value(s) and dimensions of the key parameter.
(i) Upper and lower parameter limits - The maximum and minimum values of the key parameter between which the parameter indication is considered "go."
(j) Test point source impedance - The nominal value of impedance seen by the ATE looking into the connector pin specified in (d) above.
(k) ATE test point signal characteristics - The nominal value(s) and dimensions of the sensor output as it appears at the output connector.
(l) Upper and lower ATE test point limit - The maximum and minimum values of the sensor output between which the signal indicates a "go" condition.
(m) Initial calibration required - A yes or no indication as to whether or not an initial calibration of the sensor is required.
(n) Frequency of calibration - The frequency of calibration required, if any, by the sensor to retain its accuracy.
(o) Remarks and additional information - Any relevant information considered pertinent or necessary.

7.3. Recommended test logic. - A separate test logic chart shall be submitted for each normal mode(s) of prime equipment operation that has a unique selected group of test points to be monitored. Based on the total field of test points selected the contractor shall arrange the test points into a recommended logical hierarchy abstracted from the design outline (see 7.1 (c)) for ATE sequential monitoring. Certain key test points shall be designated as performance monitoring points and shall be kept to a minimum. Performance monitoring test points, whose indications may depend upon indications of other test points, shall be the ones which are capable of monitoring the performance of an entire equipment or a major portion of an equipment. The relationship of performance monitoring test points, external power source test points, equipment mode test points, fault location test points and virtual test points shall be graphically indicated on a test logic chart similar to figure 3. Each test point shall be identified by its test point number.

8. DESIGN REVIEW CONTROL

8.1 Guidance meeting. - After date of the contract or date of letter contract, the contractor shall request and recommend a date for a meeting to be arranged by the procuring activity. The purpose of the meeting will be to arrive at a format and timetable for data submission, and to delineate the particulars of the design review cycle as called out in the contract. This meeting may be part of the over-all guidance meeting called for in MIL-T-24309.

8.1.1 Preparation for guidance meeting. - The contractor shall prepare and submit to the procuring activity, a skeleton data presentation format depicting the proposed form of data submission in response to section 7 of this standard. This submission should include the information described herein, in addition to other documentation

deemed necessary for the conduct of a design review. The submission should precede the meeting date by at least 4 weeks in order to facilitate guidance.

8.2 Preparation and submission of data.- Six copies of all data required by 7.1 shall be submitted to the procuring activity as the information is developed in accordance with a schedule determined at the guidance meeting of 8.1. The contractor shall review the comments submitted on the interim data and make all modifications, deletions and additions required. The final submission shall include all corrections and shall form the final ATE test point data requirements.

9. VERIFICATION

9.1 All parameters required by 7.2 for ATE test points shall be verified by actual measurement on the produced equipment.

Review activities:
Navy-SH,AS,EC,OS

Preparing activity:
Navy-SH
(Project MISC-N492)

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