METRIC
MIL-T-24721(NAVY)
27 June 1989

MILITARY SPECIFICATION

TRANSMITTERS, LIGHT SIGNAL, DIGITAL, FIBER OPTIC, SHIPBOARD (METRIC) GENERAL SPECIFICATION FOR

This specification is approved for use by the Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for fiber optic digital transmitters for use in Naval shipboard systems. The transmitter accepts a digital electrical signal compatible with a specified logic interface, converts it to an optical signal, and transmits it as a digital optical signal through the optical output interface. The transmitter does not alter the encoding format of the incoming signal.

1.2 Classification. Transmitters are classified as specified in 1.2.1 through 1.2.4 (see 6.2).

1.2.1 Type. The type designation defines the type of light source.

(a) Type 1 - Light-emitting diode (LED).
(b) Type 2 - Laser diode (LD).

1.2.2 Wavelength class. The wavelength class designation indicates the nominal wavelength of the output optical signals.

(a) Class A - 1.31 micrometers (μm).
(b) Class B - 1.55 μm.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5105 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6025

1.2.3 Data signaling rate (DSR). The maximum allowable data rate of the transmitter falls within one of the following ranges based upon a baseband non-return to zero (NRZ) line code:

(a) Range 1 - from 0 to less than 20 megabits per second (Mbps).
(b) Range 2 - from 20 to less than 500 Mbps.
(c) Range 3 - from 500 to less than 2 gigabits per second (Gbps).
(d) Range 4 - Greater than 2 Gbps.

1.2.4 Style. The style designation defines the style of packaging.

(a) Style A - Dual inline package using multimode pigtail.
(b) Style B - Dual inline package using single-mode pigtail.
(c) Style C - Dual inline package, multimode, connectorized.
(d) Style D - Dual inline package, single-mode, connectorized.
(e) Style E - Surface mount package using multimode pigtail.
(f) Style F - Surface mount package using single-mode pigtail.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks 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, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-T-24721/1 - Transmitter, Digital, Fiber Optic, Shipboard, DC to 16 Mbps (Manchester Encoded). (Metric)
MIL-M-38510 - Microcircuits, General Specification for.
MIL-M-55565 - Microcircuits, Packaging of.

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
MIL-STD-883 - Test Methods and Procedures for Microelectronics.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) 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 cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

455-6 - Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices.

455-36 - Twist Test for Fiber Optic Connecting Devices.

(Application for copies should be addressed to Electronic Industries Association, 2001 Eye Street, NW, Washington DC 20006.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the individual item specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.4.

3.3 Reliability. Transmitter reliability shall be expressed as a mean time to failure (MTTF), in hours of operation, and shall be as specified (see 3.1). Reliability shall be determined by procedures specified in 4.6.1. Transmitter failure criteria shall be as specified (see 3.1). The number of test units shall be as specified (see 6.2).

3.3.1 Burn-in (see 4.3.1.2). All units shall meet the requirements of MIL-STD-883, method 1015.

3.4 Materials. Transmitters shall be constructed of materials that will not produce toxic, corrosive, or explosive by-products. Materials shall not have adverse effects upon operational or maintenance personnel under all operational and environmental conditions, nor cause degradation of equipment performance (see 4.6.2 and 6.3).

3.4.1 Recovered materials. Unless otherwise specified, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using raw materials produced from recovered bulk materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of partially processed, assembled, or rebuilt products is allowed under this specification.

3.5 Design and construction. The transmitter shall be of the design and construction as specified (see 3.1).

3.5.1 Fiber optic pigtail. Transmitter styles A, B, E, and F shall be supplied with a fiber or cable pigtail (see 6.6.6, 6.6.7) as specified (see 3.1 and 6.2). One end of the pigtail shall be permanently mounted in the transmitter case, and the mounting construction may provide strain relief for the pigtail in order to meet the requirements of paragraph 3.11. The pigtail length shall be not less than 1 meter. No metal components shall be used within the pigtail, except for mounting to the transmitter case or termination connector.

3.5.2 Fiber optic connector. Transmitter styles C and D shall be supplied with a fiber optic connector as specified (see 3.1).

3.5.3 Optical source. The transmitter shall use an LED or an LD as specified (see 3.1).

3.5.4 Case (see 4.6.3.1). The transmitter shall be hermetically sealed in a metal case. No adhesive or polymeric materials shall be used for case lid attachment, sealing, or repair; only welding or soldering is permitted. All adhesive materials shall meet the requirements of MIL-STD-883, method 5011. Dimensions, pinouts, and pinout functions shall be as specified (see 3.1). The number of pins on each transmitter shall be one of the following: 14, 16, 18, 20, 24, as specified (see 3.1). The transmitter case shall be electrically grounded, connected to a voltage pin, or electrically isolated (that is, floating) as specified (see 3.1).

3.5.5 Terminals. The terminals shall meet the requirements as specified in 3.5.5.1 and 3.5.5.2.

3.5.5.1 Terminal strength (see 4.6.3.2). The electrical terminals shall reveal no evidence of breakage, loosening, or relative motion between the electrical terminals and the case of the transmitter. The terminals shall meet the requirements as specified (see 3.1).

3.5.5.2 Solderability (see 4.6.3.3). Terminal solderability shall meet the temperature and time requirements as specified in MIL-STD-883, method 2003.

3.6 Maintainability. The individual transmitters are regarded as lowest replaceable units and are not repairable, nor do they require maintenance.

3.7 Performance requirements. The transmitter shall meet all performance requirements of 3.7.1 and 3.7.2 with an electrical input signal specified in 4.6.4.1.2.

3.7.1 Output optical signal characteristics.

3.7.1.1 Optical power spectrum.

3.7.1.1.1 Peak emission wavelength (see 4.6.4.2, 6.6.8). The peak emission wavelength shall be as specified (see 3.1).

3.7.1.1.2 Spectral width (see 4.6.4.2, 6.6.12). The spectral width shall be as specified (see 3.1).

3.7.1.2 Optical power levels (see 4.6.4.3). The minimum and maximum optical power output levels shall be as specified (see 3.1).

3.7.1.2.1 Steady state (see 4.6.4.3). The optical power output level corresponding to a steady-state logical HIGH shall be as specified (see 3.1).

3.7.1.2.2 Pulsed output (see 4.6.4.3). The difference between the average optical power level corresponding to a pulsed output and the optical power level corresponding to a steady-state output shall be as specified (see 3.1). Unless otherwise specified (see 3.1), the electrical pulse input shall be a 50 percent duty cycle NRZ digital signal.

3.7.1.2.3 Extinction ratio (see 4.6.4.3, 6.6.2). Unless otherwise specified (see 3.1), the extinction ratio of the transmitter shall be not less than 20:1.

3.7.1.3 Optical waveform characteristics.

3.7.1.3.1 Rise and fall times (see 4.6.4.4, 6.6.10). The rise and fall times shall be as specified (see 3.1).

3.7.1.3.2 Overshoot and undershoot (see 4.6.4.4). The allowable overshoot or undershoot shall be as specified (see 3.1).

3.7.2 Electro-optical characteristics.

3.7.2.1 Input-to-output logic signal phase (see 4.6.4.5). Unless otherwise specified (see 3.1), the input-to-output logic signal phase shall be non-inverting.

3.7.2.2 Pulse-width distortion (see 4.6.4.5, 6.6.9). The allowable pulse-width distortion shall be as specified (see 3.1).

3.7.2.3 Signal propagation delay (see 4.6.4.5, 6.6.11). The allowable signal propagation delay shall be as specified (see 3.1).

3.7.2.4 Short circuit protection (see 4.6.4.6). The transmitter shall not experience any degradation of performance following application and removal of an electrical short between any required functional pin and logic ground or between any functional pin and supply voltage.

3.7.3 Power supply voltage and current (see 4.6.4.7). The transmitter shall operate with one or more of the following nominal direct current (dc) supply voltages: plus and/or minus 5 volts, plus and/or minus 12 volts, plus and/or minus 18 volts, plus and/or minus 24 volts, or plus and/or minus 28 volts as specified (see 3.1). The transmitter shall meet all electrical and optical performance requirements specified herein while operating with specified power supply voltages, currents, and their tolerances (see 3.1). The total transmitter power consumption shall not exceed the level specified (see 3.1).

3.8 Safety. Transmitter design and operation shall conform to the safety standards of MIL-STD-454, requirement 1.

3.8.1 Laser safety. Type 2 transmitters shall be labeled as specified (see 3.1).

3.9 Environmental requirements. The transmitter shall meet all performance requirements under the following environmental conditions and as specified (see 3.1).

3.9.1 Environmental temperature extremes (see 4.6.5.1). The transmitter shall meet the performance requirements of 3.7.1 and 3.7.2 at the operating temperature extremes. The transmitter environmental temperature range shall be as specified (see 3.1), in accordance with the ranges in table I. The change in optical output power over the temperature range shall be less than 4.0 decibels, or as specified (see 3.1). The transmitter shall have no physical damage (see 4.6.3.4).

TABLE I. Environmental temperature ranges.

Temperature range	Operating (°C)	Nonoperating (°C)
1	0 to +85	-62 to +85
2	-28 to +85	-62 to +85
3	-54 to +85	-62 to +85
4	0 to +125	-62 to +125
5	-28 to +125	-62 to +125
6	-54 to +125	-62 to +125

3.9.2 Vibration (see 4.6.5.2). The transmitter shall not develop cracks, chips, warping, bending, or other physical damage (see 4.6.3.4).

3.9.3 Thermal shock (see 4.6.5.3). The test requirements shall be met using the nonoperating temperature range specified (see 3.9.1), and shall have no cracks, breaks, or other physical damage (see 4.6.3.4).

3.9.4 Impact shock (see 4.6.5.4). The transmitter shall not develop cracks, breaks, or other physical damage (see 4.6.3.4).

3.9.5 Salt spray (see 4.6.5.5). The transmitter shall meet the requirements of MIL-STD-883, method 1009.

3.9.6 Explosive atmosphere (see 4.6.5.6). The transmitter shall operate safely in flammable atmospheres without causing an explosion.

3.9.7 Fungus resistance (see 4.6.5.7). All materials used in the construction of the transmitter shall meet the requirements of MIL-STD-454, requirement 4. Materials not identified in MIL-STD-454, requirement 4, as fungus inert, shall meet the requirements of grade I of MIL-STD-810, method 508.

3.9.8 Environmental screening (see 4.3.1.3, 4.3.1.4). The transmitter shall be environmentally screened by random vibration testing (see 4.3.1.3) and by temperature cycling (see 4.3.1.4).

3.10 Mechanical requirements (see 4.6.6).

3.10.1 Cable pull-out force (see 4.6.6.1). The minimum cable-to-transmitter pull-out strength shall be a minimum of 50 percent of the specified tensile strength of the attached cable or 100 newtons, whichever is less. There shall be no cable jacket damage, cable clamp failure, cable-to-transmitter seal damage, distortion or bending of transmitter parts, or cable disengagement from the clamp (see 4.6.3.4).

3.10.2 Twist (see 4.6.6.2). Cable-to-transmitter seals shall meet the requirements of 3.17.

3.10.3 Connector pull-out force (see 4.6.6.3). The minimum connector-to-transmitter pull-out strength shall be one-half of the specified tensile strength of the attached connector or 100 newtons, whichever is less. There shall be no connector-to-transmitter seal damage, distortion or bending of transmitter parts, or connector disengagement from the transmitter (see 4.6.3.4).

3.10.4 Fiber dynamic strength (see 4.6.6.4). The minimum fiber dynamic strength shall be 50 percent of the specified proof strength of the attached fiber. There shall be no fiber-to-transmitter seal damage, or distortion or bending of transmitter parts (see 4.6.3.4).

3.11 Nuclear radiation resistance. The performance requirements of 3.7 shall be met when tested in accordance with 4.6.7, unless otherwise specified (see 3.1).

3.12 Electromagnetic effects (see 4.6.8). The transmitter shall meet the conducted and radiated emission requirements, and the conducted and radiated susceptibility requirements of MIL-STD-461, part 5, as specified (see 3.1). Above-deck or below-deck application shall be as specified (see 3.1).

3.13 Electrostatic discharge sensitivity (ESDS) (see 4.6.9). The transmitter shall meet the requirements of 3.8, and the requirements for ESDS class 2 devices in MIL-STD-883.

3.14 Dimensions (see 4.6.10). The transmitter shall be enclosed in a physical envelope with detailed dimensions as specified (see 3.1).

3.15 External finish (see 4.6.11). The transmitter case finish shall comply with the package finish (external finish) requirements of MIL-M-38510. Unless otherwise specified (see 3.1), the pins shall be tin plate finished in accordance with MIL-M-38510.

3.16 Identification marking (see 4.6.12). Unless otherwise specified (see 3.1), the transmitter shall be marked in accordance with MIL-M-38510. The assigned part number shall use the numbering schemes specified (see 6.7).

3.17 Workmanship. The transmitter shall meet the requirements specified in MIL-STD-883 (see 4.3.1.1 and 4.6.3.4).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspections herein are classified as follows:

(a) Screening inspection (see 4.3).
(b) First article inspection (see 4.4).
(c) Quality conformance inspection (see 4.5).

4.3 Screening inspection. Each transmitter to be delivered or submitted for inspection shall have been subjected to, and passed, all of the screening tests of table II in the order shown. Transmitters with cable pigtails may be subjected to these tests before the pigtail exterior is installed over the coated fiber. For those transmitters with pigtails to be cabled after screening, a temporary strain relief may be installed at the transmitter/pigtail interface for the screening tests.

TABLE II. Screening inspection.

Inspection	Requirement	Test
Internal visual	3.17	4.3.1.1
Burn-in	3.3.1	4.3.1.2
Random vibration	3.9.8	4.3.1.3
Temperature cycling	3.9.8	4.3.1.4
External visual	3.17	4.6.3.4
Hermetic seal	3.5.4	4.6.3.1

4.3.1 Inspection conditions. Inspection conditions shall be met as specified in the applicable test method for each inspection parameter, and as specified (see 3.1).

4.3.1.1 Internal visual (see 3.17). Internal visual inspection (pre-cap) shall be performed in accordance with MIL-STD-883, method 2017.

4.3.1.2 Burn-in (see 3.3.1). Burn-in testing and acceptance shall be in accordance with MIL-STD-883, method 1015. Unless otherwise specified (see 3.1), all samples shall be tested for a minimum of 160 hours at the maximum temperature specified in table I. Maximum power supply voltage and the appropriate signal voltage to provide maximum optical power level shall be applied to the transmitter during the test (see 3.7.3 and 3.7.1.2.1).

4.3.1.3 Random vibration (see 3.9.8). Random vibration testing and acceptance shall be in accordance with MIL-STD-883, method 2026, condition II, test condition C. No power shall be applied during this test.

4.3.1.4 Temperature cycling (see 3.9.8). Temperature cycling testing and acceptance shall be in accordance with MIL-STD-883, method 1010, using the specified nonoperating temperature range in table I. No power shall be applied during this test.

4.4 First article inspection (see 3.2). Inspection shall include the tests of groups I, II, III, and IV of table III, as specified (see 6.2 and 6.3). Each sample unit shall successfully pass all screening tests (see 4.3) prior to performing group I tests. All sample units used for groups II, III, and IV testing shall have successfully passed group I testing. Tests within a group, using the same sample unit, shall be performed in the sequence shown in table III.

4.4.1 Samples. Unless otherwise specified (see 6.2), the number of sample units to be subjected to first article inspection shall be seven transmitters, not including those required for reliability testing (see 3.3). The samples shall be taken at random from a production run and shall be produced with equipment and procedures intended for production of final units by the manufacturer. For transmitters with cable pigtails, those units to be subjected to group II tests may have the pigtail exterior installed after the hermetic seal test. For those transmitters with pigtails to be cabled after hermetic seal testing, a temporary strain relief may be installed at the transmitter/pigtail interface for those tests prior to hermetic seal testing.

TABLE III. First article inspection.

Inspection	Requirement	Test	Sample size (see 4.4.1)
Group I			
Identification marking	3.16	4.6.12	1/
Peak emission wavelength	3.7.1.1.1	4.6.4.2	1/
Spectral width	3.7.1.1.2	4.6.4.2	1/
Steady-state optical power	3.7.1.2.1	4.6.4.3	1/
Pulsed optical power	3.7.1.2.2	4.6.4.3	1/
Extinction ratio	3.7.1.2.3	4.6.4.3	1/
Rise and fall times	3.7.1.3.1	4.6.4.4	1/
Overshoot and undershoot	3.7.1.3.2	4.6.4.4	1/
Input-to-output logic signal phase	3.7.2.1	4.6.4.5	1/
Pulse-width distortion	3.7.2.2	4.6.4.5	1/
Signal propagation delay	3.7.2.3	4.6.4.5	1/
Short circuit protection	3.7.2.4	4.6.4.6	1/
Power supply voltage and current	3.7.3	4.6.4.7	1/
Dimensions	3.14	4.6.10	1/
External finish	3.15	4.6.11	1/
Workmanship	3.17	4.6.3.4	1/
Temperature extremes	3.9.1	4.6.5.1	1/
Group II			
Terminal strength	3.5.5.1	4.6.3.2	1
Solderability	3.5.5.2	4.6.3.3	2/
Thermal shock	3.9.3	4.6.5.3	1
Impact shock	3.9.4	4.6.5.4	3/

See footnotes at end of table.

TABLE III. First article inspection - Continued.

Inspection	Requirement	Test	Sample size (see 4.4.1)
Vibration	3.9.2	4.6.5.2	3/
Salt spray	3.9.5	4.6.5.5	3/
Mechanical tests	3.10	4.6.6	3/
Hermetic seal	3.5.4	4.6.3.1	3/
Explosive atmosphere	3.9.6	4.6.5.6	3/
Fungus resistance	3.9.7	4.6.5.7	3/
Group III			
Electromagnetic effects	3.12	4.6.8	1
Electrostatic discharge sensitivity	3.13	4.6.9	4/
Group IV			
Reliability	3.3	4.6.1	see 3.3
Nuclear radiation resistance	3.11	4.6.7	4

1/ All samples shall be subjected to group I inspections.
2/ The same sample shall be used as in the terminal strength inspection.
3/ The same sample shall be used as in the thermal shock inspection.
4/ The same sample shall be used as in the electromagnetic effects inspection.

4.5 Quality conformance inspection. Quality conformance inspection shall include the inspections of groups A, B, and C in tables IV, V, and VI, as specified (see 6.2). Each transmitter shall successfully pass all screening tests (see 4.3) prior to performing group A inspections. Group B samples must have successfully completed Group A inspections. Group C samples must have successfully completed group A and B inspections.

4.5.1 Group A inspection. The group A inspections shall be nondestructive tests, consisting of visual, mechanical, and performance tests as provided in table IV and as specified (see 3.1). Each transmitter shall comply with the group A requirements prior to delivery or prior to group B testing, and shall be tested in the order shown.

TABLE IV. Group A inspection.

Inspection	Requirement	Test
Identification marking	3.16	4.6.12
Peak emission wavelength	3.7.1.1.1	4.6.4.2
Spectral width	3.7.1.1.2	4.6.4.2
Steady-state optical power	3.7.1.2.1	4.6.4.3
Pulsed optical power	3.7.1.2.2	4.6.4.3
Extinction ratio	3.7.1.2.3	4.6.4.3
Rise and fall times	3.7.1.3.1	4.6.4.4
Overshoot and undershoot	3.7.1.3.2	4.6.4.4
Input-to-output logic signal phase	3.7.2.1	4.6.4.5
Pulse-width distortion	3.7.2.2	4.6.4.5
Signal propagation delay	3.7.2.3	4.6.4.5
Short circuit protection	3.7.2.4	4.6.4.6
Power supply voltage and current	3.7.3	4.6.4.7
Temperature extremes	3.9.1	4.6.5.1

4.5.2 Group B inspection. The group B inspections shall be nondestructive tests in table V and as specified (see 3.1).

4.5.2.1 Inspection sequence. For transmitters with cable pigtails, those units to be subjected to group B inspection may have the pigtail exterior installed after the hermetic seal test. For those transmitters, a temporary strain relief may be installed at the transmitter interface for all tests prior to hermetic seal testing. Group B inspections shall be tested in the sequence shown.

TABLE V. Group B inspection.

Inspection	Requirement	Test
Impact shock	3.9.4	4.6.5.4
Thermal shock	3.9.3	4.6.5.3
Fiber dynamic strength (styles A, B, E, and F only; see 1.2.4)	3.10.4	4.6.6.4
Hermetic seal	3.5.4	4.6.3.1
Cable pull-out force (for cable pigtailed units only)	3.10.1	4.6.6.1

4.5.3 Group C inspection. The group C inspections shall consist of tests in table VI and as specified (see 3.1). These tests may be destructive to sample parts. Unless otherwise specified (see 6.2), samples for each test shall consist of subsets of group B test samples. For transmitters with cable pigtails, the cable exterior may be removed prior to hermetic seal testing.

TABLE VI. Group C inspection.

Inspection	Requirement	Test
Reliability	3.3	4.6.1
Nuclear radiation assistance	3.11	4.6.7
Terminal strength	3.5.5.1	4.6.3.2
Twist (for cable pigtailed units only)	3.10.2	4.6.6.2
Connector pull-out force (for connectorized units only)	3.10.3	4.6.6.3
Electromagnetic effects	3.12	4.6.8
Electrostatic discharge sensitivity	3.13	4.6.9
Vibration	3.9.2	4.6.5.2
Hermetic seal	3.5.4	4.6.3.1
Explosive atmosphere	3.9.6	4.6.5.6
Solderability	3.5.5.2	4.6.3.3
Salt spray	3.9.5	4.6.5.5
Fungus resistance	3.9.7	4.6.5.7

4.6 Methods of inspection.

4.6.1 Reliability (see 3.3). The transmitter failure rate shall be determined for class B devices (as defined in MIL-STD-883) using MIL-STD-883, method 1016, except that the minimum ambient temperature shall be 150 degrees Celsius (°C). Input electrical signal corresponding to the characteristics specified in 4.6.4.1.2 at the minimum pulse width and maximum duty cycle shall be used. The power supply shall be set to the maximum specified in 3.7.3. Proper device operation shall be determined by verifying the average optical output power using the test specified in 4.6.4.3.

4.6.2 Materials (see 3.4). Materials inspection shall consist of determination that the materials used in fabricating the transmitters are in accordance with 3.4.

4.6.3 Design and construction inspections.

4.6.3.1 Hermetic seal (see 3.5.4). The transmitter shall be tested and accepted in accordance with MIL-STD-883, method 1014, methods A1 and C. For transmitters with cable pigtails see 4.3, 4.4.1, 4.5.2.1, and 4.5.3, as applicable.

4.6.3.2 Terminal strength (see 3.5.5.1). The transmitter electrical terminals shall be tested and accepted in accordance with MIL-STD-883, method 2004. Test condition A shall be used for tension; condition B1 shall be used for stress; and condition B2 shall be used for electrical pin fatigue.

4.6.3.3 Solderability (see 3.5.5.2). The transmitter electrical pins shall be tested and accepted in accordance with MIL-STD-883, method 2003.

4.6.3.4 Visual inspection (see 3.17). Transmitters shall be visually inspected and accepted in accordance with MIL-STD-883, method 2009.

4.6.4 Performance tests.

4.6.4.1 General. The performance tests for the transmitter shall be performed with the transmitter having not less than 1-meter length of fiber connected. For a style C or D transmitter (see 1.2.4) the connector and the fiber or cable comprising the pigtail shall meet the requirements as specified (see 3.1). Measurements shall be made using an input electrical signal corresponding to the characteristics specified in 4.6.4.1.2. Measurements shall be made at the output end of the optical pigtail while applying the appropriate cladding mode stripper (see 6.6.1). For single-mode fiber, the pigtail shall be wrapped one turn around a 30-millimeter (mm) diameter mandrel.

4.6.4.1.1 Standard test conditions. Unless otherwise specified (see 3.1), the following ambient test conditions shall be used:

Temperature: 25°C + 3, -5°C

Relative humidity: 50 ± 30 percent

Atmospheric pressure: 725 ± 75 mm of mercury

4.6.4.1.2 Standard electrical input characteristics. The characteristics of the electrical input signal to the transmitter shall be as specified (see 3.1). These characteristics include the following:

(a) Logic family compatibility (in accordance with MIL-M-38510).
(b) Pulse width (maximum and minimum).
(c) Duty cycle (maximum and minimum).
(d) Waveform characteristics.
(e) Rise and fall times (maximum) (see 6.6.10).
(f) Overshoot and undershoot (maximum percent).

4.6.4.2 Optical power spectrum (see 3.7.1.1.1, 3.7.1.1.2). This test shall verify that the peak emission wavelength and the spectral width are as specified (see 3.7.1.1.1 and 3.7.1.1.2).

The test set-up shall be as shown on figure 1.

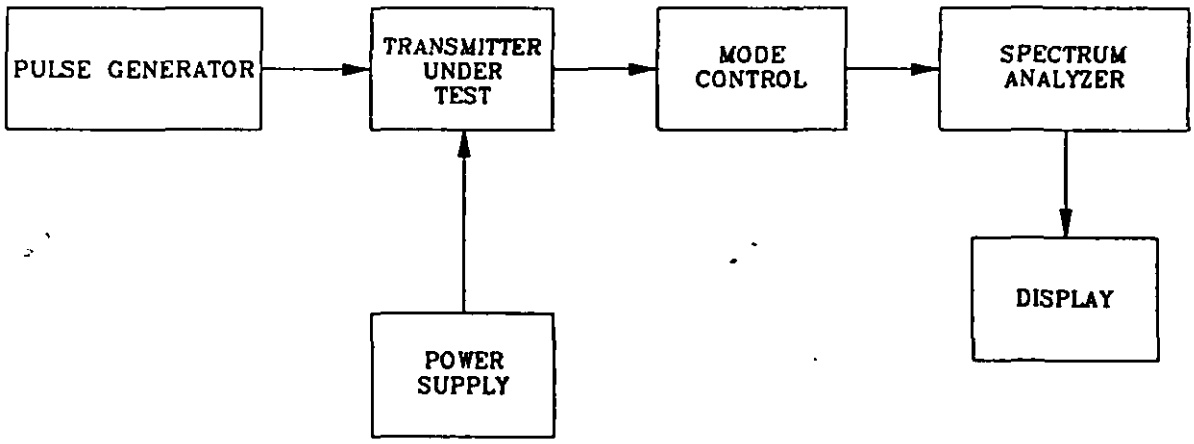
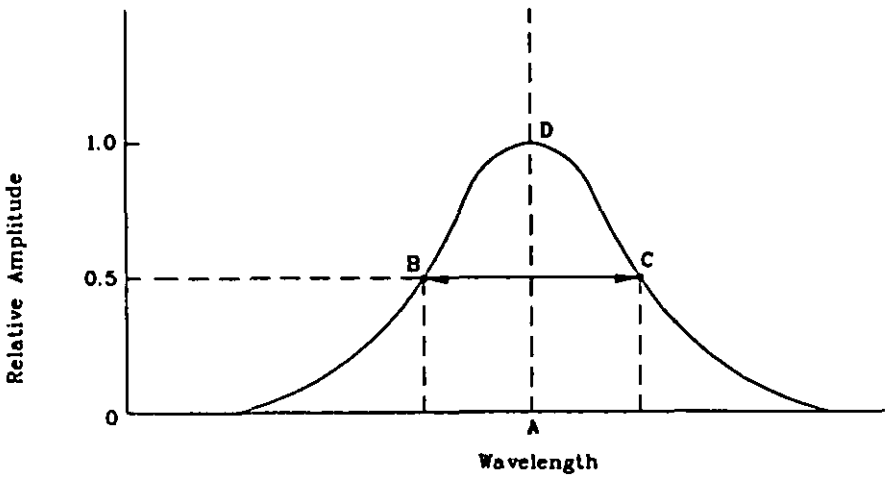


FIGURE 1. Optical power spectrum test set-up.



A = Peak emission wavelength
BC = Full-width half-maximum
D = Peak emission power level

FIGURE 2. Optical spectral envelope (LEDs).

The test procedure shall be as follows:

1. Standard ambient test conditions shall be as specified in 4.6.4.1.1.
2. The transmitter shall be connected to the apparatus that provides the specified conditions.
3. The power supply voltage shall be set to the minimum magnitude specified (see 3.7.3).
4. The optical spectrum analyzer shall have sufficient spectral wavelength range, responsivity, and resolution to measure the spectral radiance of the transmitter under test. Any spectrum analyzer may be used if it is sensitive enough to measure the optical power spectrum and provides repeatable readings with less than 3 percent variation.

5. The input shall be a 50 percent duty-cycle pulse with a period equal to twice the minimum pulse width.
6. The peak emission wavelength of an LED transmitter shall be determined as shown on figure 2, at point A, by observing point D. For a laser transmitter, the same process applies to the output wavelength having the greatest amplitude.
7. a. For LED transmitters measure the spectral width at the full-width half-maximum (FWHM) power points as shown between points B and C on figure 2.
   b. For multifrequency laser transmitters, calculate the root mean square (rms) width, as shown on figure 3 between points A and B. The RMS width shall be calculated as follows: RMS = $\Delta\lambda$ = [$1/P_o$ Σ_i P_i $(\lambda_i - \lambda_c)^2$]$^{0.5}$ where P_o = the sum of the peak optical output powers (see 4.6.4.3); P_i = peak optical power at each output wavelength; λ_i = center of an individual optical output wavelength at peak power (P_i); λ_c = statistical center wavelength given by $\lambda_c = 1/P_o \Sigma_i P_i \lambda_i$.
   c. For single frequency laser transmitters measure the full width at minus 10 decibels referenced to zero decibels at the peak emission power level.
8. The results shall be verified in accordance with the requirements of 3.7.1.1.
9. The power supply shall be set to the maximum magnitude specified (see 3.7.3). Steps 5 through 8 shall be repeated.
10. The power supply voltage shall be set to the specified nominal magnitude in the specification sheet. Steps 5 through 8 shall be repeated.

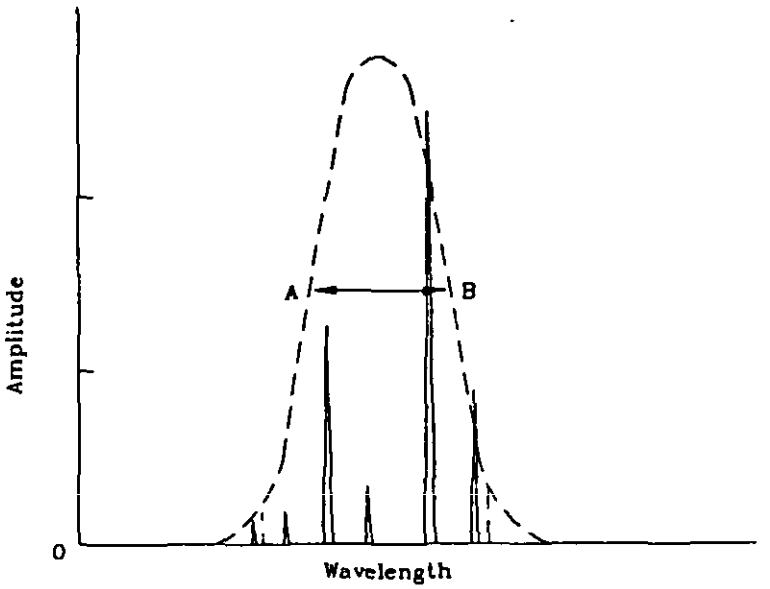


FIGURE 3. Optical spectral envelope (multifrequency lasers).

4.6.4.3 Optical power levels. The intent of this test is to verify that the steady-state power level (3.7.1.2.1), the pulsed power level (3.7.1.2.2), and the extinction ratio (3.7.1.2.3) are as specified.

The test set-up shall be as shown on figure 4:

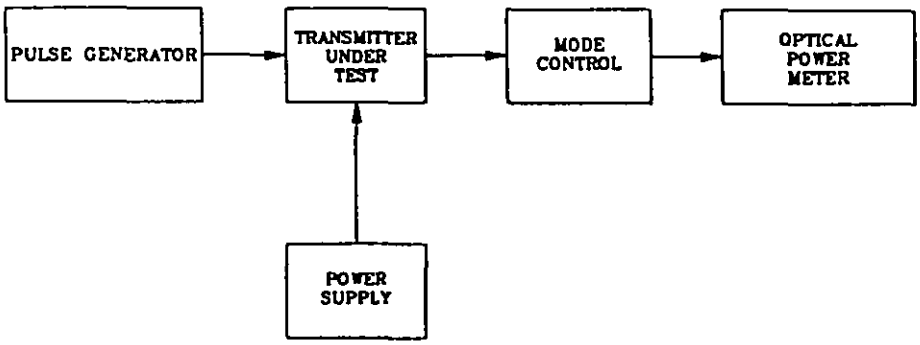


FIGURE 4. Optical power level test set-up.

The test procedure shall be as follows:

1. Standard ambient test conditions shall be as specified in 4.6.4.1.1.
2. The transmitter shall be connected to the apparatus that provides the specified conditions.
3. The power supply voltage shall be set to the minimum magnitude specified (see 3.7.3).
4. The optical power meter shall operate over the specified wavelength range and have a dynamic range suitable for the specified optical power level measurements. Any optical power meter may be used if it is sensitive enough to measure differential optical power levels and if it provides repeatable readings with less than 3 percent variation.
5. Unless otherwise specified (see 3.1), the input electrical signal shall be in accordance with the logic interface specified in 4.6.4.1.2. Any other test signals are as specified (see 3.1). For dc-coupled transmitters, the input signal shall correspond to a logic HIGH. The steady-state power level shall be measured.
6. For dc-coupled transmitters, the input shall be a signal corresponding to a logic LOW. The extinction ratio shall be calculated by dividing the high-level steady-state power level by the low-level steady-state power level. For ac-coupled transmitters, the extinction ratio shall be measured dynamically.
7. The input shall be a 50 percent duty-cycle pulse with a period equal to twice the minimum pulse width. The average optical power level shall be measured.
8. The results shall be verified to be in accordance with the requirements of 3.7.1.2.
9. The power supply shall be set to the maximum magnitude specified (see 3.7.3). Steps 5 through 8 shall be repeated.
10. The power supply voltage shall be set to the specified nominal magnitude specified (see 3.7.3). Steps 5 through 8 shall be repeated.

4.6.4.4 Optical waveform characteristics. This test shall verify that the optical waveform characteristics, rise and fall time (3.7.1.3.1), and overshoot and undershoot (3.7.1.3.2) do not exceed the values specified.

The test set-up shall be as shown on figure 5:

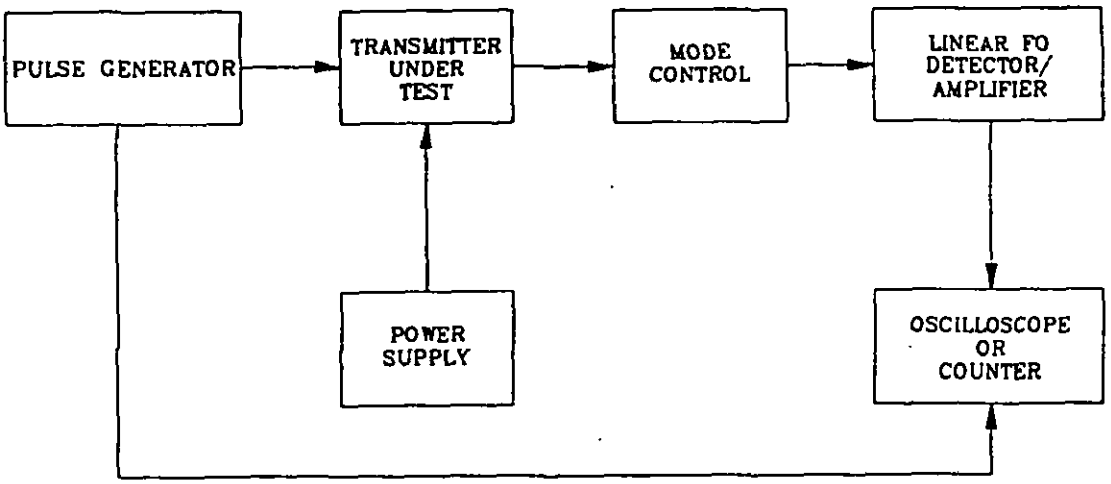
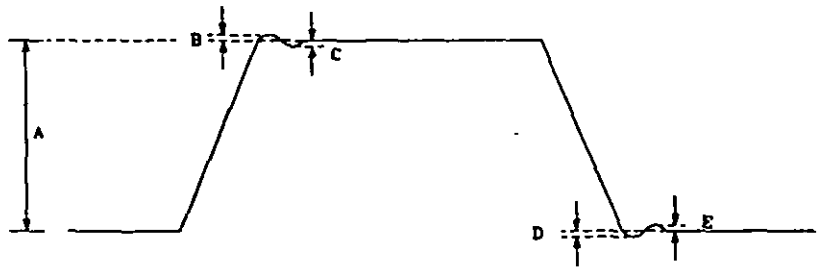


FIGURE 5. Optical waveform characteristics test set-up.

The test procedure shall be as follows:

1. Standard ambient test conditions shall be as specified in 4.6.4.1.1.
2. The transmitter shall be connected to the apparatus that provides the specified conditions.
3. The dc power supply voltage shall be set to the minimum magnitude specified (see 3.7.3).
4. The composite rise and fall times and the overshoot and undershoot of the test equipment shall not cause more than 3 percent inaccuracy of measurements. Alternatively, the resultant measurements shall be corrected for the identified inaccuracies of the measurement equipment.
5. Unless otherwise specified (see 3.1), the input electrical signal shall be in accordance with paragraph 4.6.4.1.2 with a pulse width of sufficient duration to define the steady state amplitude. Any other test signals shall be as specified (see 3.1).
6. The rise and fall times shall be measured in accordance with MIL-STD-883, method 3004.
7. The absolute overshoots and undershoots, B, C, D, and E shall be measured (see figure 6). The relative overshoots and undershoots, B', C', D', and E', shall be calculated.
8. The results shall be verified in accordance with the requirements of 3.7.1.3.
9. The power supply voltage shall be set to the maximum specified magnitude (see 3.7.3). Steps 5 through 8 shall be repeated.
10. The power supply voltage shall be set to the nominal specified (see 3.7.3). Steps 5 through 8 shall be repeated.



A = Average steady-state value
B = Rise overshoot absolute value
C = Rise undershoot absolute value
D = Fall overshoot absolute value
E = Fall undershoot absolute value

FIGURE 6. Overshoot and undershoot.

4.6.4.5 Electro-optical characteristics. The intent of this test is to verify that the electro-optical characteristics (input-to-output logic signal phase, pulse-width distortion, and signal propagation delay) are as specified (see 3.7.2.1, 3.7.2.2, and 3.7.2.3).

The test set-up shall be as shown on figure 5.

The test procedure shall be as follows:

1. Standard ambient test conditions shall be as specified in 4.6.4.1.1.
2. The transmitter shall be connected to the apparatus that provides the specified conditions.
3. The dc power supply voltage shall be set to the minimum magnitude specified (see 3.7.3).
4. The composite rise and fall times and the overshoot and undershoot of the test equipment shall not cause more than 3 percent inaccuracy of measurements. Alternatively, the resultant measurements shall be corrected for the effects of the measurement equipment.
5. Unless otherwise specified (see 3.1), the input electrical signal shall be in accordance with paragraph 4.6.4.1.2 with a pulse width of sufficient duration to define the steady state amplitude. A steady-state optical output shall have been reached. Other test signals shall be as specified (see 3.1).
6. Unless otherwise specified (see 3.1), the propagation delay shall be measured using the procedure provided in the appendix to this specification.
7. The input-to-output signal logic phase shall be determined as inverting or non-inverting.
8. The input signal shall be the specified minimum pulse width with a 50 percent duty cycle. The pulse-width distortion shall be calculated as the absolute value of the difference between the input and output pulse width when measured at the full-width half-maximum value.
9. The results shall be verified in accordance with the requirements of 3.7.2.
10. The power supply voltage shall be set to the maximum magnitude specified (see 3.7.3). Steps 5 through 9 shall be repeated.
11. The power supply voltage shall be set to the nominal magnitude specified (see 3.7.3). Steps 5 through 9 shall be repeated.

4.6.4.6 Short circuit protection (see 3.7.2.4). The short circuit protection shall pass the tests of MIL-STD-883, method 3011.

4.6.4.7 Power supply voltage and current (see 3.7.3). The maximum current shall be measured and verified in accordance with MIL-STD-883, method 3005, using the nominal supply voltage specified.

4.6.5 Environmental tests (see 3.9). The following environmental tests (except 4.6.5.5) shall be performed using a square-wave electrical input signal at both the minimum and maximum pulse width at the average pulsed power level and maximum duty cycle.

4.6.5.1 Environmental temperature extremes (see 3.9.1). The performance of the transmitter shall be verified in accordance with 4.6.4 at both of the operating temperature extremes as specified (see 3.9.1). The transmitter shall have attained thermal equilibrium for at least 30 minutes before any measurements are made. Thermal equilibrium is defined as the low temperature minus zero degrees, plus 1 degree Celsius; or the high temperature plus zero degrees, minus 1 degree Celsius.

4.6.5.2 Vibration (see 3.9.2). The transmitter shall be tested for effects of vibration in accordance with MIL-STD-883, method 2026, test condition II, test condition C, and method 2007 test condition A. Verification of performance shall be in accordance with 4.6.4.3 through 4.6.4.5 during and after the test.

4.6.5.3 Thermal shock (see 3.9.3). The effects of thermal shock on transmitter performance shall be tested using MIL-STD-883, method 1011, over the nonoperating temperature range specified. Verification of performance shall be in accordance with 4.6.4.3 through 4.6.4.5 after the test.

4.6.5.4 Impact shock (see 3.9.4). The transmitter shall be subjected to physical shock using MIL-STD-883, method 2002, test condition B. Unless otherwise specified (see 3.1), pulsed power shall be monitored during this test with equipment having a time resolution of 1 microsecond. Verification of performance shall be in accordance with 4.6.4.3 during the test, and 4.6.4.3 through 4.6.4.5 after the test.

4.6.5.5 Salt spray (see 3.9.5). The transmitter shall be tested in accordance with MIL-STD-883, method 1009, test condition C.

4.6.5.6 Explosive atmosphere (see 3.9.6). The transmitter safe operation within explosive atmospheric environments shall be verified by using MIL-STD-202, method 109, under conditions as specified (see 3.1).

4.6.5.7 Fungus resistance (see 3.9.7). Transmitters and materials used in the construction of the transmitters, that are not identified as fungus inert, shall pass the tests of MIL-STD-810, method 508.

4.6.6 Mechanical tests (see 3.10).

4.6.6.1 Cable pull-out force (see 3.10.1). The transmitter shall be tested in accordance with EIA 455-6. The axial tensile load shall be applied to the load specified and shall be maintained for 10 minutes. The pulsed power shall be verified during and after the test (see 4.6.4.3).

4.6.6.2 Twist (see 3.10.2). The transmitter shall be tested in accordance with EIA 455-36, with the exception that the test sample shall be a properly pigtailed transmitter. The number of loads to be applied shall be one. The pulsed power shall be verified during and after the test (see 4.6.4.3).

4.6.6.3 Connector pull-out force (see 3.10.3). The transmitter shall be tested in accordance with EIA 455-6, with the exception that the test sample shall be a connector on the transmitter. The axial load shall be applied to the load specified and shall be maintained for 10 minutes. The pulsed power shall be verified during and after the test (see 4.6.4.3).

4.6.6.4 Fiber dynamic strength (see 3.10.4). The fiber pigtail dynamic strength shall be tested as follows: The fiber pigtail shall have an axial tensile load applied up to the load specified at an angle of 45 degrees to the normal (see figure 7). With the load applied, the pigtail shall be rotated through one rotation (360 degrees). The pulsed power shall be verified during and after the test (see 4.6.4.3).

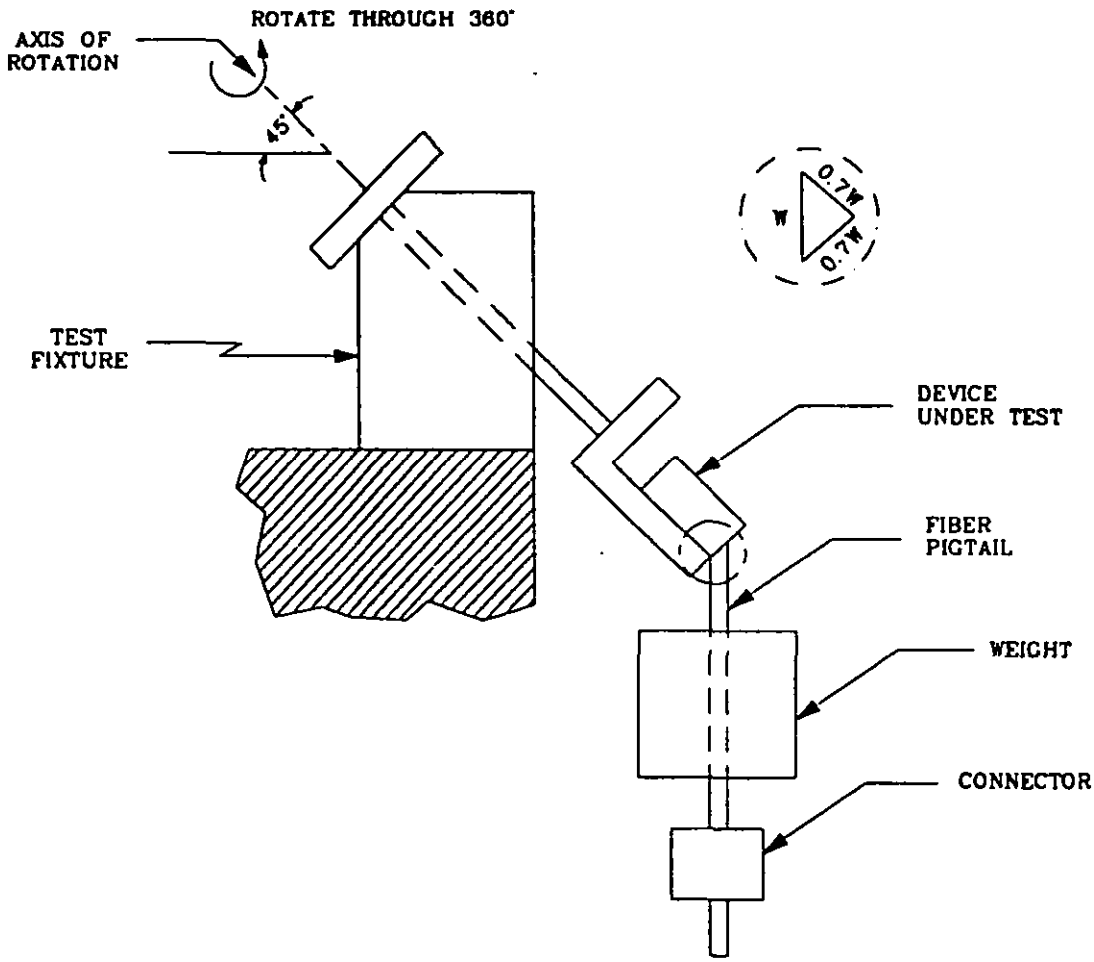


FIGURE 7. Fiber dynamic strength test set-up.

4.6.7 Nuclear radiation resistance (see 3.11). The transmitter shall be subjected to radiation in accordance with MIL-STD-883, methods 1017 (neutron) and 1019 (total dose) and the applicable specification sheet (see 3.1). Pulsed power shall be monitored continuously during the neutron and total dose tests. The dose rates and exposure times shall be as specified (see 6.2). Verification of performance shall be in accordance with 4.6.4.3 during the test and 4.6.4 after the test. Three test temperatures are required; the low and the high operating temperatures (see table I), and 20°C.

4.6.8 Electromagnetic effects (see 3.12). The transmitter shall be tested for effects of electromagnetic emissions in accordance with MIL-STD-462 as applicable and as specified (see 3.1). Verification of performance shall be in accordance with 4.6.4.3 through 4.6.4.5 during and after the test.

4.6.9 Electrostatic discharge sensitivity (see 3.13). The transmitter shall be tested for sensitivity to electrostatic discharge in accordance with MIL-STD-883, method 3015. Unless otherwise specified (see 3.1), the electrostatic pulse shall be not less than 3000 volts. Verification of performance shall be in accordance with 4.6.4 after the test.

4.6.10 Dimensions (see 3.14). The transmitter shall be inspected for compliance with unit dimensions and tolerances using MIL-STD-883, method 2016.

4.6.11 External finish (see 3.15). The external finish of the transmitter case shall be verified using MIL-STD-883, method 2009.

4.6.12 Identification markings (see 3.16). The transmitter markings shall be examined for legibility and required information using MIL-STD-883, method 2009. The marking shall be legible and complete, and shall meet the resistance to solvents in accordance with MIL-STD-883, method 2015.

4.6.13 Inspection of packaging. The sampling and inspection of the preservation, packaging, and container marking shall be in accordance with the requirements of MIL-M-55565.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in 2.0, see 6.9.)

5.1 Preservation and packing. The transmitter shall be packaged for shipment and preservation in accordance with MIL-M-55565.

5.2 Marking. Marking on the transmitter packaging shall be in accordance with MIL-M-38510.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The transmitters specified herein are intended for the generation of optically transmitted, digital data signals. The transmitter applications may include any signal data use within its operating range as specified in this document.

6.1.1 Engineering information. MIL-R-24720 is the companion specification on digital fiber optic shipboard receivers. Although the companion specification is not involved in the classification or testing of transmitters, it is often useful for evaluating the fiber optic link system.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of the specification.
(b) Type, class, DSR range, and style required (see 1.2).
(c) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(d) Title, number and the date of the specification sheet.
(e) Number of test units required for reliability testing unless testing is waived (see 3.3).
(f) Appropriate specification for the pigtail when units are supplied with a fiber optic pigtail (see 3.5.1).
(g) When first article is required and test information (see 4.4).
(h) First article sample and lot size (see 4.4.1).
(i) Quality conformance inspection information (see 4.5).
(j) Nuclear radiation dose rates and exposure times, when test is required (see 4.6.7).
(k) Part number of transmitter (see 6.7).
(l) Quantity required.

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.4	DI-R-2121	Certificate of compliance	----
4.4	DI-T-4902	First article inspection report	----

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 First article. When a first article inspection is required, the first article should consist of seven units. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4.1 Lot size. The lot size may be specified contractually, if desired.

6.5 Quality conformance. Quality conformance inspections require contractual definition of the overall test program, including sample sizes and lot sizes, if appropriate (see 4.5).

6.6 Definitions.

6.6.1 Cladding mode stripper. A cladding mode stripper is a material applied to cladding to allow electromagnetic energy being transmitted in the cladding to leave the cladding.

6.6.2 Extinction ratio. The extinction ratio is the ratio of two optical power levels, P_1/P_2, of a digital signal generated by a light source, where P_1 is the optical power level generated when the light source is "on" and P_2 is the power level generated when the light source is "off".

6.6.3 Fiber cladding. Fiber cladding is a transparent material that surrounds the core of an optical fiber and that has a lower index of refraction than the core material.

6.6.4 Fiber coating. Fiber coating is a protective material bonded to an optical fiber over the cladding for various purposes, such as preserving fiber strength, inhibiting cable losses, protecting against mechanical damage (microbending), protecting against moisture and other debilitating environments, providing compatibility with fiber and cable manufacturing processes, and providing compatibility with jacketing processes.

6.6.5 Fiber core. A fiber core is the central portion of an optical fiber. The core has a higher refractive index than the cladding that surrounds it. The bulk of light energy is confined to and propagates in the core. Single-mode fiber core diameters range from 2 to 11 micrometers, depending on the numerical aperture, core radius, and wavelength of the incident light.

6.6.6 Optical cable pigtail. An optical cable pigtail is a short length of fiber optic cable permanently fixed to a component and is used to couple optical power between it and another optical cable pigtail or fiber optic cable, such as a transmission cable.

6.6.7 Optical fiber pigtail. An optical fiber pigtail is a short length of optical fiber permanently fixed to a component and is used to couple optical power between it and another optical fiber pigtail or a transmission fiber.

6.6.8 Peak emission wavelength. The peak emission wavelength is the wavelength at which a light source emits its maximum optical power.

6.6.9 Pulse-width distortion. Pulse-width distortion is the difference between the width of the electrical input pulse and the width of the corresponding optical output pulse.

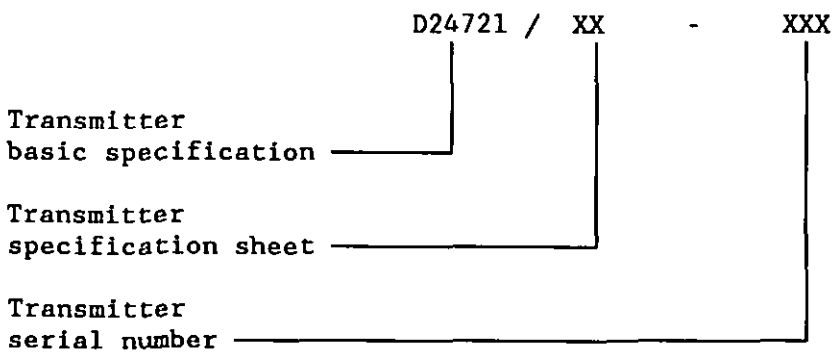
6.6.10 Rise and fall time. The rise and fall times are transition times and are defined as the time required to pass between two reference levels. These reference levels are located 10 percent of the total distance between the two limit levels above the low level and below the high level. Rise time is defined as the time to pass from the low level to the high level, and fall time is the time to pass from the high level to the low level.

6.6.11 Signal propagation delay. Signal propagation delay is the time required for a signal to travel from one point to another, e.g., in an optical transmitter, the time interval between the leading edge of an electrical input pulse and the leading edge of the corresponding optical output pulse.

6.6.12 Spectral width. Spectral width is the wavelength interval in which a radiated spectral quantity is a specified fraction of its maximum value. The fraction is usually taken at 0.5 of the maximum power level, and is the full-width half-maximum value.

6.7 Part number.

6.7.1 Part or Identifying Number (PIN). The PINs to be used for transmitters acquired to this specification are created as follows:



Examples: D24721/01-001
D24721/02-001

6.8 Part designator. A part designator if specified (see 3.1) should include classifications (see 1.2) as follows:

1. Type (see 1.2.1)
2. Wavelength class (see 1.2.2)
3. Data signaling rate (see 1.2.3)
4. Style (see 1.2.4)

Example: 1A2B

6.9 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.10 Subject term (key word) listing.

Digital transmitter
Fiber optic communications
Fiber optic component
Fiber optic transmitter
Laser diode
Light emitting diode
Multimode transmitter
Multifrequency laser
Optical connectorized component
Optical pigtailed device
Optical power source
Optical wavelength
Single mode transmitter
Surface mount component

APPENDIX

TEST PROCEDURE TO MEASURE OUTPUT PROPAGATION DELAY

10. SCOPE

10.1 Scope. This appendix is intended to provide the instructions for measuring the output propagation delay under specified conditions. 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. TEST EQUIPMENT

30.1 Test equipment. The test apparatus shall supply the necessary power supply voltages and currents, electrical data input signals, and any control input signals as specified.

40. TEST SAMPLE

40.1 Test sample. Select an appropriate digital fiber optic terminal device.

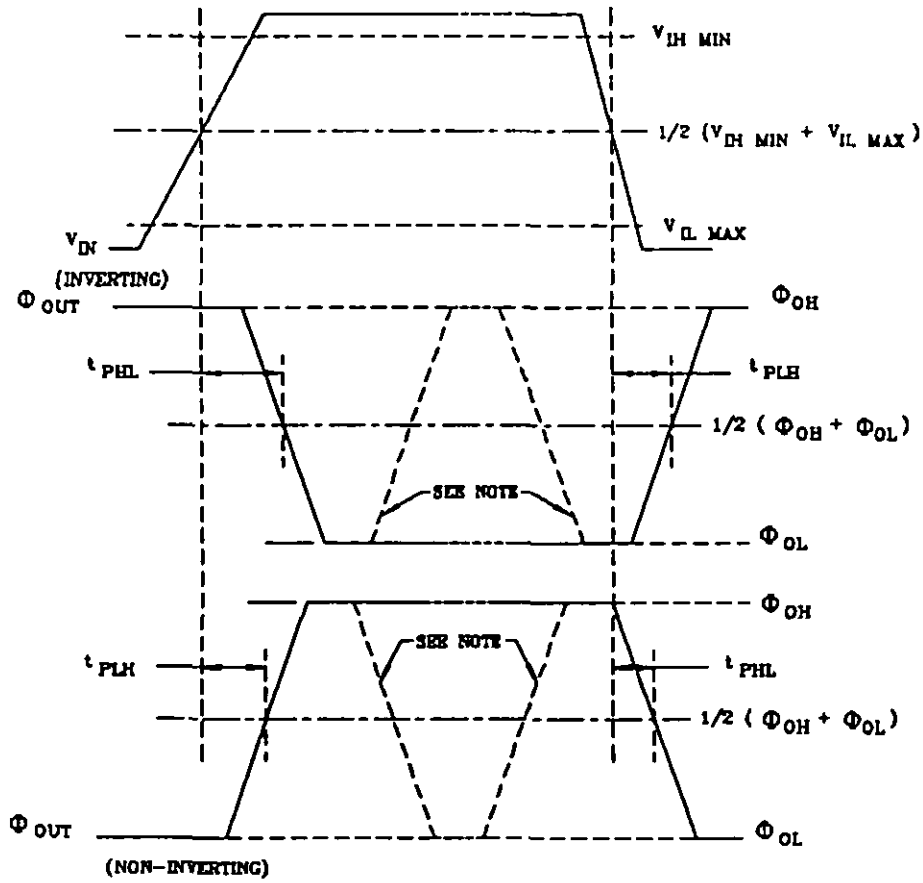
50. TEST PROCEDURE

50.1 Test procedure. The test procedure shall be as follows:

(a) The ambient or reference point temperature shall be as specified.
(b) The device shall be connected to the test apparatus providing the specified conditions.
(c) The supply voltages and currents and any control input signals shall be set to their specified values.
(d) The data input signal, V_{in}, shall be varied within the specified limits at the specified frequency and pulse width.
(e) The output propagation delay times shall then be measured between the specified points on the input and output waveforms as follows:

t_{PHL} - with the output changing from the defined HIGH state to the defined LOW state.
t_{PLH} - with the output changing from the defined LOW state to the defined HIGH state.

(f) The points on the input and output waveforms, between which the delay times are measured, shall be as follows: As shown on figure 1, where the input high level voltage (V_{IH}) minimum and the input low level voltage (V_{IL}) maximum are the specified values and the high level output (Φ_{OH}) and the low level optical output (Φ_{OL}) are the measured values of Φ_{out}. NOTE: Φ_{OL} may be zero.
(g) The supply voltages and input signals shall then be reduced to zero and the device removed from the test apparatus.



NOTE: Where the device incorporates code conversion, or output line coding resulting in other than a bilevel optical output, the measurement requirements shall be as specified.

FIGURE 1. Transmitter waveforms.

Review activities:
Navy - EC, YD

Preparing activity:
Navy - SH
(Project 6025-N001)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-T-24721(NAVY)	TRANSMITTERS, LIGHT SIGNAL, DIGITAL, FIBER OPTIC SHIPBOARD (METRIC) GENERAL SPECIFICATION FOR

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
b. ADDRESS *(Street, City, State, ZIP Code)*	

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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PREVIOUS EDITION IS OBSOLETE.