

MIL-W-87967

12 DECEMBER 1980

MILITARY SPECIFICATION

WATCH, WRIST: DIGITAL

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

1. SCOPE

1.1 Scope. This specification covers multi-function, battery-powered, quartz crystal, liquid crystal digital display wristwatches (including strap) employing solid state integrated circuitry.

1.2 Classification. Wristwatches covered by this specification shall be of the types and classes specified herein (see 6.1).

1.2.1 Type I. Features of the Type I wristwatch are as follows:

- a. Twenty-four hour general purpose watch
- b. Single time zone (24 hour) four position display
- c. Stopwatch (1 hour minimum)
- d. Water resistant (3 atmospheres/45 PSI)
- e. Shock resistant

1.2.1.1 Classes. Classes are as follows:

- a. Class A: Self-luminous lighting
- b. Class B: Incandescent lighting

1.2.2 Type II. Features of the Type II wristwatch are as follows:

- a. Divers watch
- b. Single time zone (24 hour) six position display with optional 12-hour time mode
- c. Autoranging stopwatch (3 hour minimum)
- d. Waterproof (5 atmospheres/75 PSI)
- e. Self-luminous lighting
- f. Shock resistant

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: AFLC CASO/LODS, Federal Center, Battle Creek MI 49016 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.2.3 Type III. Features of the Type III wristwatch are as follows:

- a. Aircrew, navigators and shallow water divers watch
- b. Single time zone (24 hour) six position display with optional 12-hour time mode
- c. Continuous seconds readout
- d. Stopwatch (1 hour minimum)
- e. Water resistant (3 atmospheres/45 PSI)
- f. Shock resistant

1.2.3.1 Classes. Classes are as follows:

- a. Class A: Self-luminous lighting
- b. Class B: Incandescent lighting

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Military

MIL-S-46383

Strap, Wrist; Instrument

STANDARDS

Military

MIL-STD-105

Sampling Procedures and Tables Inspection by Attributes

MIL-STD-109

Quality Assurance Terms and Definitions

MIL-STD-202

Test Methods for Electronic and Electric Component Parts

MIL-STD-810

Environmental Test Methods

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

CODE OF FEDERAL REGULATIONS

U.S. Nuclear Regulatory Commission, Rules and Regulations, Title 10, Chapter 1.

Part 30 - Rules of General Applicability to Licensing of By-Product Material

Part 32 - Specific Licenses to Manufacture, Distribute, or Import
Exempt and General Licensed Items Containing By-Product
Material

(Application for copies should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402.)

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), the contractor shall furnish six sample unit(s) for first article inspection and approval (see 4.5 and 6.2).

3.2 Materials and parts. All materials shall be of uniform quality and free of defects which might impair the functioning or accuracy of the watch. Material which is not specified by a definite material specification shall be of a composition and quality that will enable the watches to meet all requirements of this specification.

3.2.1. Metal parts.

3.2.1.1 External. All external metal case parts shall be resistant against salt water corrosion as per MIL-STD-810 Salt Fog Test and resistant against human perspiration as per accelerated lactic acid test (see 4.7.4.8).

3.2.1.2 Internal. The spring material used for power cell contacts shall be phosphor bronze or equivalent. The positive contact for the power cell shall be plated 0.1 micron thickness of bright gold. The negative power cell contact shall be either stainless steel or plated bright gold 0.1 micron in thickness.

3.2.2 Radiation limit for self-luminous watches. The amount of radiation in the continuous self-luminous light source shall not exceed the maximum per watch as specified for timepieces in Title 10, Chapter 1, Part 30 of the Code of Regulations of the Nuclear Regulatory Commission.

3.3 Design and construction.

3.3.1 General design. The watch shall have a corrosion resistant nonreflective metal case with stainless steel back, plastic or glass crystal, removable electronic module and a strap of woven nylon. The design shall insure that the watch is waterproof or water resistant, shock resistant, and shall be made to withstand the normal strain of jars, vibrations and hot and cold environments incident to shipping, storage and service.

3.3.2 Module. The watch module shall be designed to be removable from the case and shall meet the specification requirements for timepieces in Title 10, Chapter 1, Part 30 of the Code of Federal Regulations of the U.S. Nuclear Regulatory Commission. It shall also contain markings to indicate power cell orientation; i.e., (+ up) or (- up). This marking shall be visible when the back cover of the case or power cell hatch is removed.

3.3.3 Power. The watch shall be powered by self-contained power cell(s) which are commercially available from a minimum of two manufacturers. The

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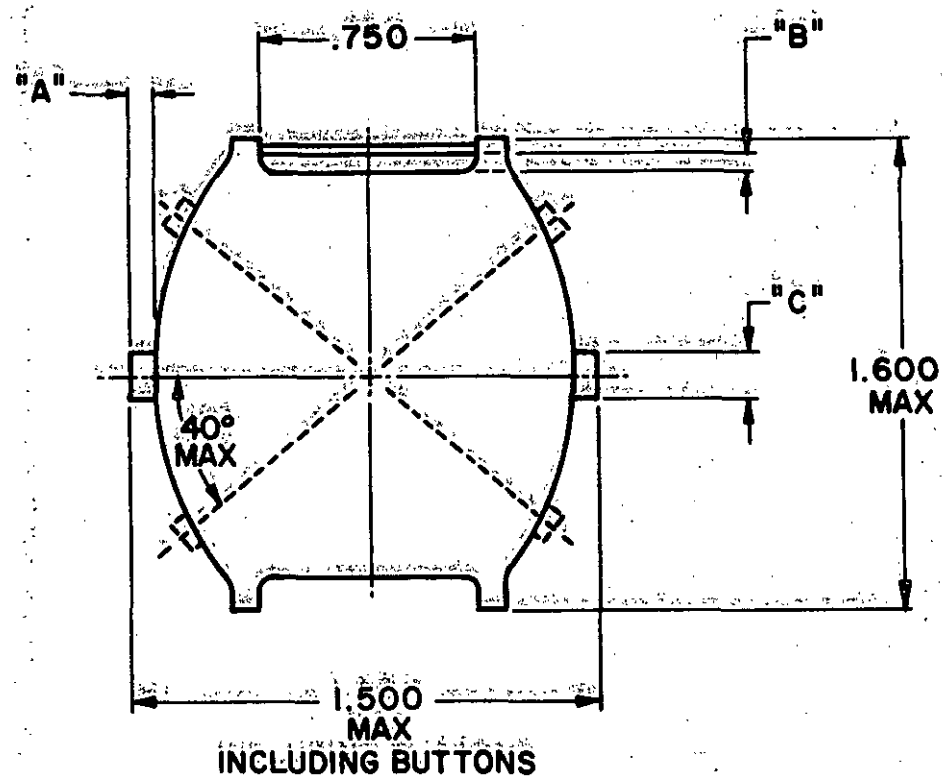
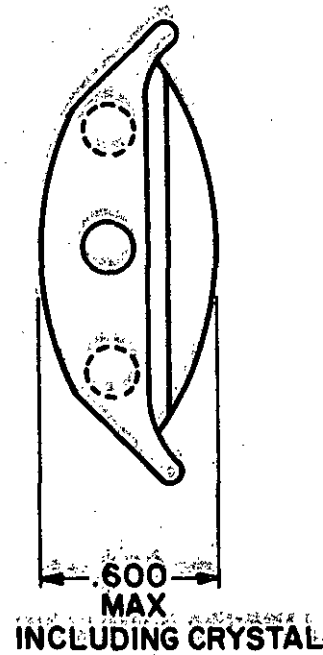
watch shall be designed to operate a minimum of 1 year on a single power cell regardless of light source based upon the number of external control switch operations as specified in 4.7.3.1. The power cell(s) shall contain orientation marks which identify the positive (+) side. If two power cells are used, one shall be used exclusively for the incandescent lighting on Class B watches. When specified (see 6.2), the power cell(s) shall be furnished with the watch.

3.3.4 External control switches. The watch shall contain a minimum of 2 but not more than 4 externally controlled switches either of a pushbutton or toggle switch type. These switches will hereafter be referred to as external control switches. The external control switches shall be located either on the horizontal center line of the case or at an angle of up to 40° from the center line of the case as shown in Figure 1. They shall also meet the minimum and maximum dimensions shown in Figure 1. The mode setting external control switches shall be either flush with the case or extended from the case. If extended, it shall not require turning of the button for setting the watch. On watches which have incandescent backlighting for the liquid crystal (Type I, Class B and Type III, Class B), one switch shall have the sole purpose of activating the lamp and shall not control other modes of the watch unless a separate power cell is used exclusively for the backlighting.

3.3.5 Time base. Type I watches shall contain all logic and external controls necessary to display the following four modes: hours and minutes; seconds; month and date; and a 1 hour stopwatch feature with minutes and seconds display. Types II and III watches shall contain all logic and external controls necessary to display hours, minutes, and seconds simultaneously; or, month, day and date; or, a stopwatch mode with minutes, seconds, and tenths or hundredths of a second resolution display. The lamp, the watch setting feature, and the various logic modes of the watch will be addressed by the external control switches. Additional time base or day or date modes may be included in the watch providing such modes neither interfere with basic modes specified above nor do such modes complicate the operation of the watch by requiring additional functions of the external control switches.

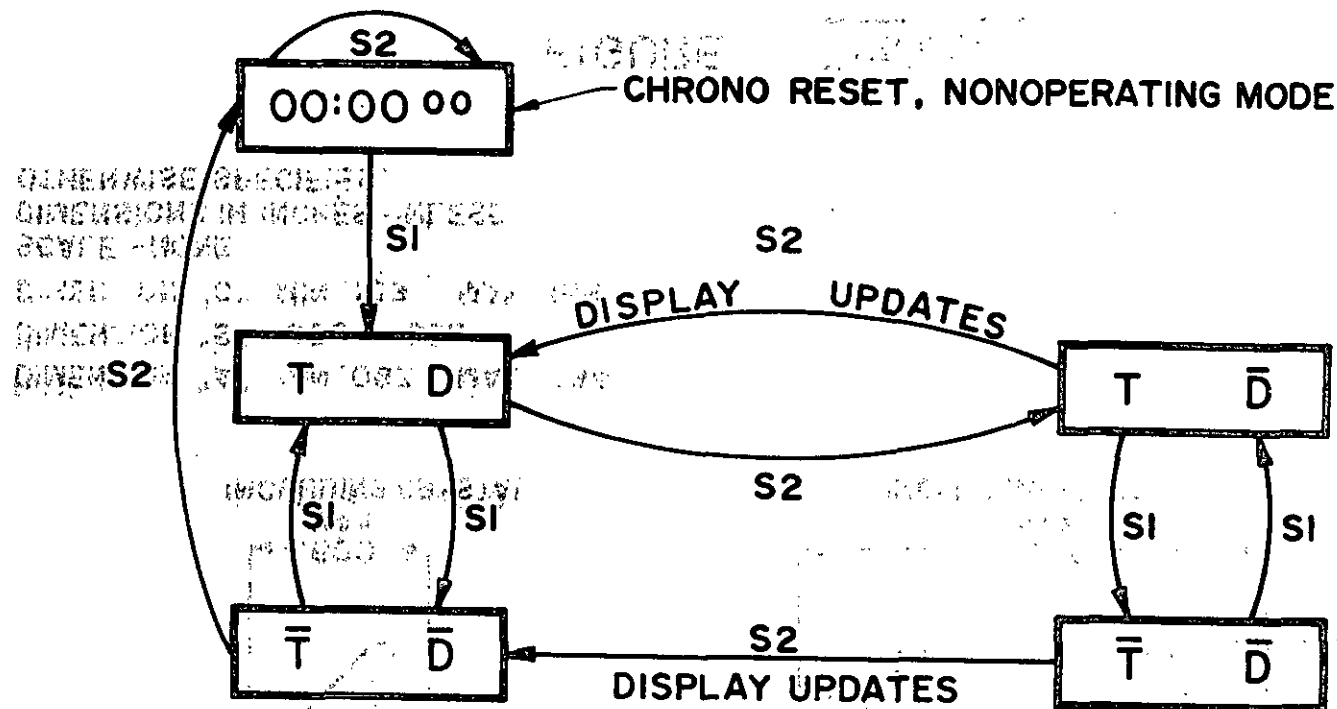
3.3.6 Logic memory. The watch shall have a memory logic to allow the chronograph stopwatch mode to accumulate multiple time events without interfering with the accumulation of time between the events (see Figure 2) and allowing for the switching between the time display and stopwatch mode without affecting either mode.

3.3.7 Autoranging chronograph. The chronograph mode on Type II watches shall accumulate time for a minimum of 3 hours and the autoranging feature shall reflect minutes in digit positions 1 and 2; seconds in digit positions 3 and 4; and tenths and hundredths of seconds in digit positions 5 and 6 during the first hour of operation. When autoranging after 1 hour elapsed time, the watch shall reflect hours in digit positions 1 and 2; minutes in digit positions 3 and 4 and seconds in digit positions 5 and 6. Digit positions are identified in Figure 3.



DIMENSION "A" MIN .063 , MAX .094
 DIMENSION "B" .050 \pm .002
 DIMENSION "C" MIN .109 , MAX .156
 SCALE - NONE
 DIMENSIONS IN INCHES UNLESS
 OTHERWISE SPECIFIED.

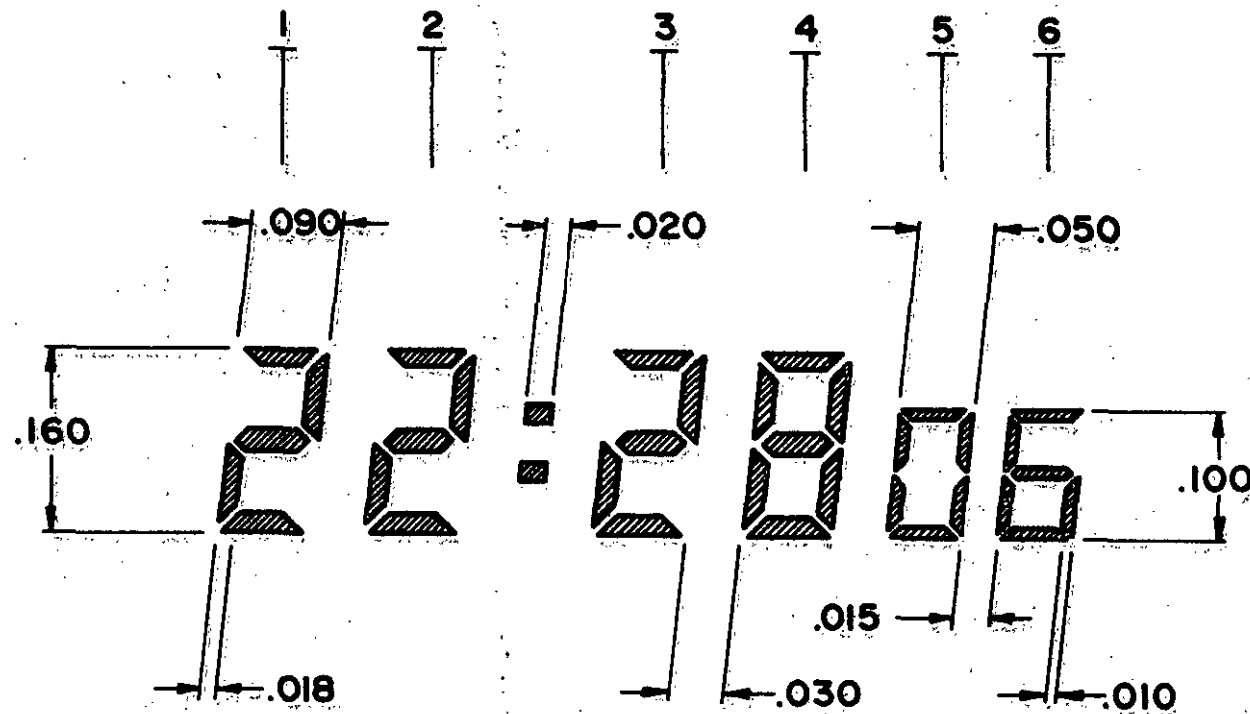
FIGURE 1. Typical Case



S1 - SWITCH 1
 S2 - SWITCH 2
 T - TIMER RUNNING
 T-bar - TIMER STOPPED
 D - DISPLAY CONTINUOUSLY CHANGING
 D-bar - DISPLAY STOPPED

FIGURE 2. Typical Chronograph Multiple Time Operation

DIGIT POSITION



NOTE:
 THE SECONDS READOUT (POSITIONS 5 & 6)
 CAN BE LOCATED ABOVE , BELOW OR THE
 RIGHT SIDE OF THE MINUTES READOUT
 (POSITIONS 3 & 4).

SCALE - NONE
DIMENSIONS IN INCHES (MIN)

FIGURE 3. Typical 24 Hour 6 Digit Watch Display

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3.3.8 Water resistance/waterproof. After activating the external control switch a minimum of ten times, the waterproof watches shall show no evidence of internal leakage when submerged at the following pressures for a minimum of 60 minutes. The daily rate of accuracy of ± 0.5 seconds shall not be exceeded.

Types I and III watches - 3 atmospheres (45 PSI)

Type II watch - 5 atmospheres (75 PSI)

3.3.9 Case assembly.

3.3.9.1 Case design. The case front shall be of plain styling and shall not contain the manufacturer's name or identification marks. Specific styling of the case will be at the discretion of the manufacturer, however, the case size shall not exceed the maximum dimensions as shown in Figure 1. Internal dimensions of the case will be as required to form a good fit for the assembled module.

3.3.9.2 Crystal. The crystal shall be made of tempered glass, mineral crystal or nonhygroscopic, thermosetting plastic. The crystal shall be clear and uncolored, and free from bubbles, striae, scratches, chips, or other imperfections which may interfere with the reading of the watch. Plastic crystals shall be mounted with an O-ring type seal or cemented in place using a clear nonhygroscopic adhesive which is nonsoluble in water and which is compatible with the plastic crystal.

3.3.9.3 Crystal strength. The crystal, when assembled to the case, shall show no evidence of cracking or chipping when tested as specified in 4.7.3.3.

3.3.9.4 Finish. All visible, exterior metal surfaces of the case assembly, excluding external control switches and spring type case bars, shall have a dull nonspecular/nonreflective finish, such as nickel-chromium; stainless steel; nickel-rhodium; nickel-tin-cobalt/tin-nickel alloys; anodized aluminum; or chromated zinc die cast. The color shall be silvery metallic or black.

3.3.9.5 Case back. Internal access shall be by means of a screw type or snap type back. The seal between the case back and case shall be accomplished by means of an O-ring. Cases with snap type backs shall have reference marks for proper alignment of case backs. The case backs may contain separate power cell hatches which are designed to allow for the easy removal and replacement of power cells, using a simple nonspecial tool specified by the manufacturer. The case backs and power cell hatches shall contain gaskets or O-rings and be designed so that there are no other parts, such as screws, springs, or clips involved in the removal and replacement of power cells. All case backs shall meet the requirements of Title 10, Chapter 1, Part 30 of the Code of Federal Regulations of the Nuclear Regulatory Commission.

3.3.10 Strap. Each watch supplied under this specification shall be equipped with a one-piece nylon strap conforming to MIL-S-46383. Types II and III watches shall be equipped with MIL-S-46383 Type III strap. The color shall be black.

3.3.11 Case bars. Watch cases shall include either integral bars or stainless steel removable spring bars for the watch strap. The case/spring bars shall be designed to accommodate a MIL-S-46383 strap and shall be capable of withstanding a static pull on the strap of up to 15 pounds on each bar without damage.

3.3.12 Liquid crystal display light readout. The liquid crystal display light readout shall be a commercial field effect watch display with a service life of 50,000 hours. It shall contain black digits on a silver-gray reflective background. The front polarizer shall be vertically oriented to the display, as indicated in Figure 4, to permit viewing with sunglasses equipped with vertical polarizers.

3.3.12.1 Digit dimensions. Type I watches shall conform to the dimensions of Figure 5. Types II and III watches shall conform to the digit dimensions of Figure 3.

3.3.12.2 Brightness and contrast. The liquid crystal display, when measured with a photometer in foot-lamberts, shall have the following contrast ratios: (The measurement shall be made under ambient lighting conditions with the backlight not illuminated.)

<u>Minimum contrast ratio</u>	<u>Incidence angle</u>	<u>Lighting condition</u>
1:1.5	30°	Uniform diffused illumination of five foot-candles
1:5.0	0°	10,000 foot-candles ambient illumination

3.3.12.3 Light sources. The module shall have either a gaseous tritium light source or incandescent electroluminescent lamp to illuminate the display for dark viewing.

3.3.12.3.1 Incandescent or electroluminescent light source. The light source for Type I, Class B, and Type III, Class B, watches shall consist of a battery-powered incandescent or electroluminescent lamp for backlighting the liquid crystal display. It shall have a maximum drain on the power cell not to exceed 17 milliamps and shall provide a minimum overall diffused luminosity across the liquid crystal display of 0.03 foot-lamberts as measured in the completed watch.

3.3.12.3.2 Continuous self-luminous light source. The continuous self-luminous light source for the Type I, Class A, and Types II and III, Class A, watches shall consist of sealed glass tubes containing a phosphorescent material and radiation source. It shall have a minimum luminosity of 0.03 foot-lamberts and a maximum luminosity of 0.05 foot-lamberts as measured in the completed watch.

3.3.12.3.3 Dark viewing. The background brightness of the incandescent, electroluminescent or self-luminous lighted background shall allow the watch to be easily read in darkness at a minimum of 12 inches from the eyes of a dark-adapted observer having normal/corrected 20/20 vision.

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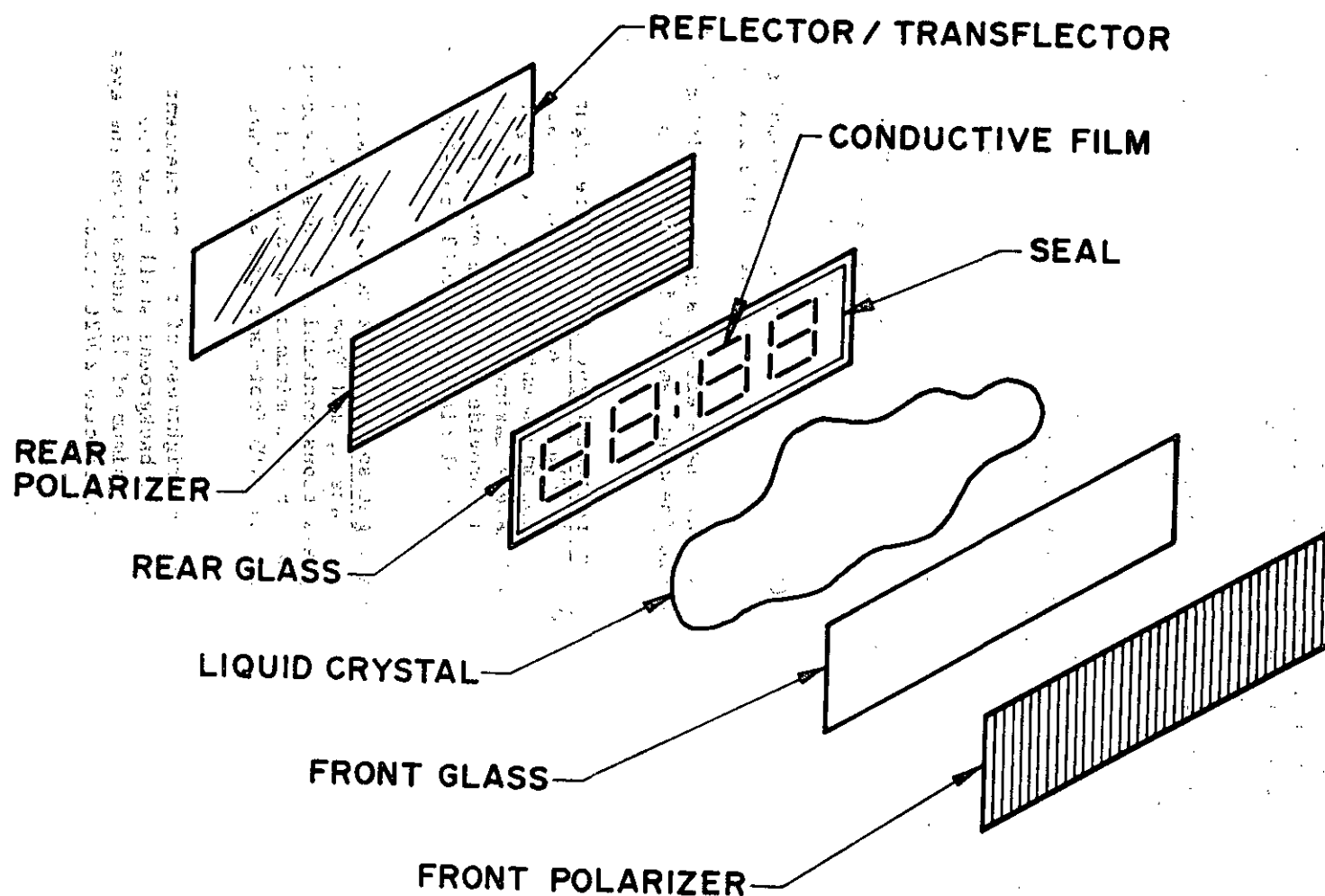
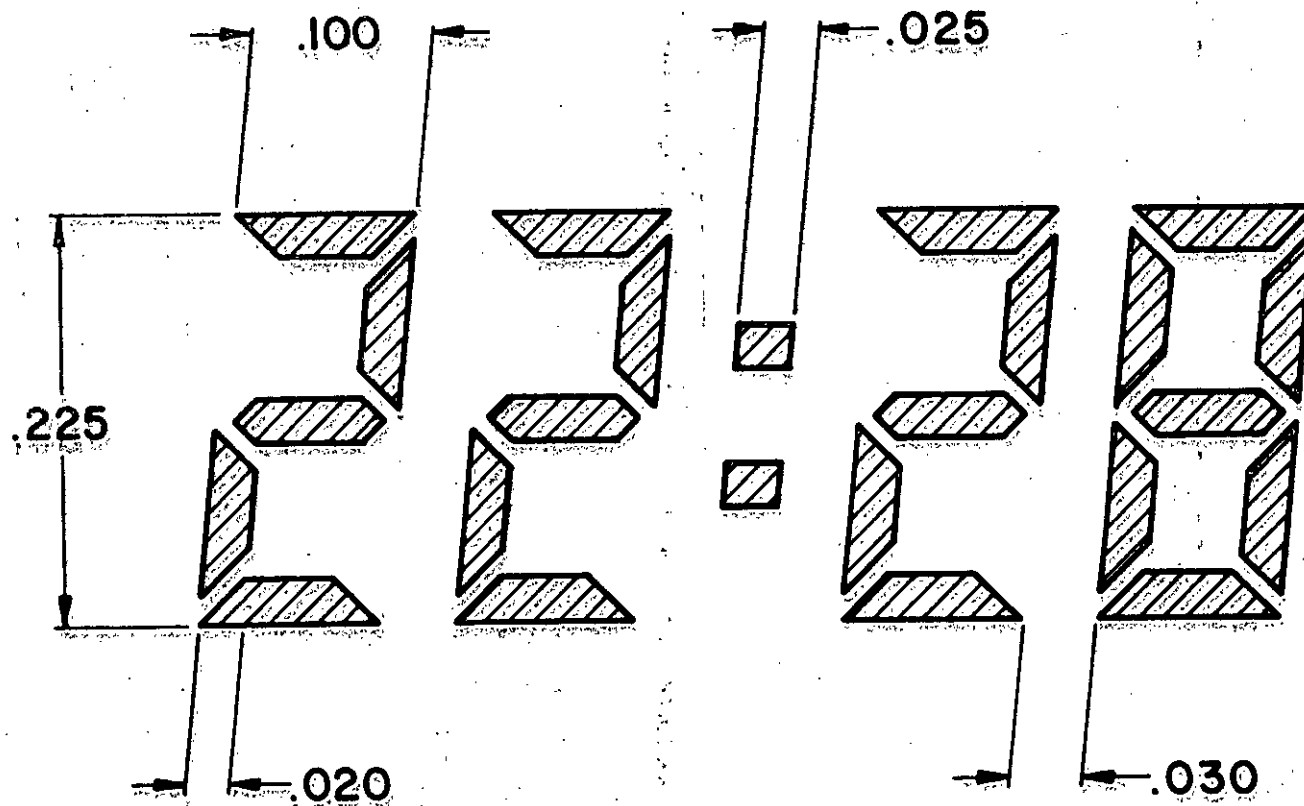


FIGURE 4. Field Effect Liquid Crystal Display



SCALE - NONE
DIMENSIONS IN INCHES (MIN)

FIGURE 5. Typical 24 Hour 4 Digit Watch Display

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3.4 Performance.

3.4.1 Synchronization. It shall be possible to set the watch, when worn on an individual's arm, to an accurate time reference ± 1.0 second.

3.4.2 Accuracy. The watches shall have a daily rate (see 6.3.2) and mean daily rate (see 6.3.3) which does not exceed the following values at temperatures specified:

<u>Temperature</u>	<u>Mean daily rate (Seconds per day)</u>
$+1^{\circ} \pm 2^{\circ}\text{C}$	3
$+26^{\circ} \pm 2^{\circ}\text{C}$	0.5
$+40^{\circ} \pm 2^{\circ}\text{C}$	3

3.4.2.1 Magnetism. While running, the daily rate shall not exceed ± 0.5 second after being subjected to a magnetic field of 125 ± 1.0 gauss in any direction.

3.4.3 Setting and display sequences. It shall be possible to operate the watch in all logic modes specified in 3.3.6 and 3.3.7 by pressing the various external control switches.

3.4.3.1 External control switch activating pressure. For Types I and III watches, the external control switches shall require no less than a minimum pressure of 5.3 ounces and no more than a maximum pressure of 10.6 ounces to activate the switch. The external control switches for the Type II divers watch shall be designed so that the switch is not activated by a water pressure of up to 5 atmospheres.

3.4.3.2 External control switch damaging force. A direct force (push) of 4.75 pounds ± 0.25 pounds, applied while setting or activating modes, shall not cause damage to the external control switches and will not cause the module to malfunction.

3.5 Environmental requirements.

3.5.1 Vibration. While running, the watch shall not be damaged by 90 minutes of simple harmonic motion having an amplitude of 0.03 inch (0.6 inch maximum total excursion), the frequency being varied uniformly between the approximate limits of 10 and 55 hertz (hz). The entire frequency range between 10 and 55 hz and return to 10 hz shall be traversed in approximately 1 minute.

3.5.2 Storage. After being subjected to storage temperatures of -20°C and $+60^{\circ}\text{C}$ for 24 hours at each temperature and returned to room temperature for 15 minutes, the watch shall show no evidence of damage which affects normal use or operation.

3.5.3 High and low temperature cycling. The watch shall show no evidence of malfunctioning nor shall the liquid crystal display wash out when exposed to a 6 hour temperature cycling test of $+5^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and $+41^{\circ}\text{C} \pm 2^{\circ}\text{C}$ as specified in 4.7.4.3.

3.5.4 Altitude. Watches shall show no evidence of damage or effect on operation when subjected to an altitude of 35,000 feet for a minimum of 30 minutes.

3.5.5 Shock. The watch shall show no evidence of damage after one uncontrolled drop, while running, from a height of 2 feet 6 inches onto a block of hardwood. Subsequent to the drop test, the daily rate accuracy shall not vary by more than ± 10 percent.

3.5.6 Salt resistance. The watch shall conform to the salt fog requirement of MIL-STD-810. This 48 hour test, using a wet, dense salt spray, shall determine the corrosive resistance of the watch case, crystal and external control switches to the effects of salt atmosphere. Upon completion of this test, there shall be no evidence of damage to the crystal or affect the operation of the external control switches.

3.5.7 Human perspiration resistance. The watch shall be subjected to an accelerated lactic acid test (see 4.7.4.8) to determine the resistance of external case metals to human perspiration. Upon completion of this test, the watch case shall show no evidence of corrosion or discoloration, as specified in 4.7.4.8.

3.6 Identification. Manufacturers' identification markings shall be limited to the case back. The back of each case shall be permanently marked as specified in Figure 6.

3.7 Operating instructions. An operating instruction, conforming to 3.7.1 shall be furnished with each watch. If watches are furnished without power cell(s) (see 6.2), the operating instructions shall be marked, stamped or printed on the top and bottom margin of the front page with the following words "power cell(s) is (are) not furnished with this watch."

3.7.1 Typical operating/setting instructions:

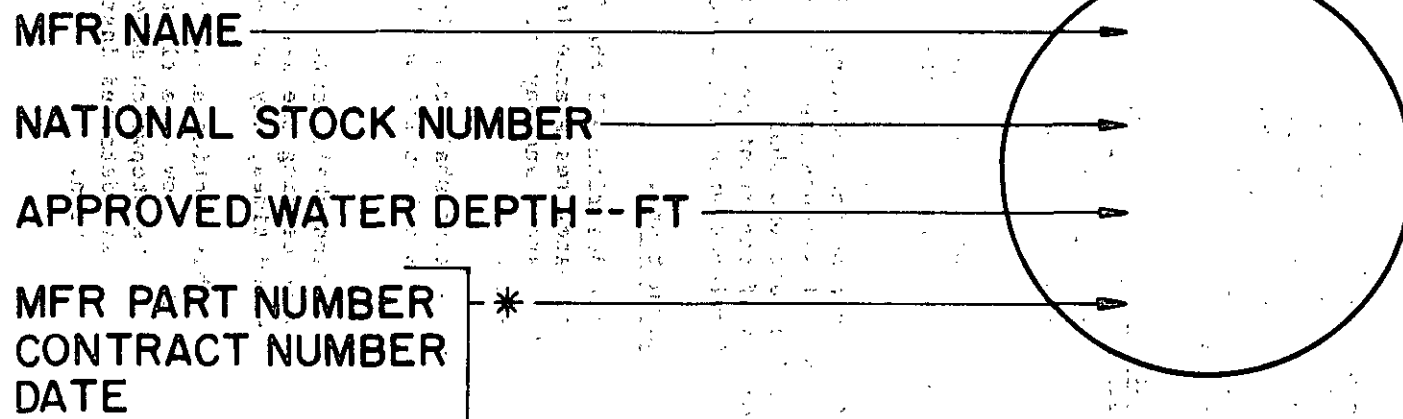
a. **General.** This section shall describe all the functions of the watch, the durability (i.e., shock and water resistance features) and accuracy that can be expected from the watch, and any precautions that should be observed during the life of the watch.

b. **Starting the watch.** This section shall contain specific step-by-step instructions on how to activate or start-up the watch if it is received not running.

c. **Setting the watch.** This section shall contain specific instructions and drawings of the LCD display concerning the setting of various functions of the watch to reflect desired times, day and month.

d. **Activating the stopwatch.** This section shall contain detailed information on activating the stopwatch and how to activate the time function without interrupting the timekeeping of the stopwatch mode. On Types II and III watches, this section shall also contain detailed instruction on the autoranging features of the stopwatch function.

IN ADDITION TO THE CASE BACK MARKINGS REQUIRED BY THE FEDERAL TRADE COMMISSION AND THE NUCLEAR REGULATORY COMMISSION, THE FOLLOWING MARKINGS SHALL BE INCLUDED ON BACK OF CASE.



* IN LIEU OF PERMANENT MARKING ON THE OUTSIDE OF CASE BACK, THIS INFORMATION MAY BE PROVIDED WITH A LABEL PLACED ON INSIDE OF CASE BACK.

FIGURE 6. Back Of Case Identification Markings

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e. Replacing the power cell(s). The section shall describe the style, type and number of power cell(s) to be used and specific instructions concerning the removal and replacement of the power cell(s). It shall also contain reference to the appropriate step listed above for resetting of the watch.

f. Warranty and servicing of the watch. This section shall contain specific instructions as to the length and terms of the warranty. It shall include detailed information concerning the requirements and manufacturer's address for obtaining service while the watch is under warranty. It shall also state the requirements necessary for factory repair service when the watch exceeds the time period of the warranty.

3.8 Workmanship. Workmanship shall be of a quality consistent with industry standards and practices. All finished surfaces shall be protected against corrosion or damage during manufacturing and prior to delivery. All material shall be of uniform quality and conditions and free from defects which may adversely affect the endurance or wear resistance of the watch.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor shall be responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractors may use their own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to insure supplies and services conform to prescribed requirements.

4.1.1 Quality assurance terms and definitions. Quality assurance terms and definitions shall be as specified by MIL-STD-109.

4.2 Certificate of compliance. When a certificate of compliance is furnished for any requirement specified herein, the Government shall have the right to check test items to determine the validity of the certification. Where defects or inferior quality is evident, and the Government deems a material analysis necessary, the contractor will be required to submit samples to the contracting officer for analysis.

4.3 Classification of inspections. The inspection requirements specified herein are as follows:

- a. First article inspection (see 4.5)
- b. Quality conformance inspection (see 4.6)

4.4 Inspection conditions.

4.4.1 Atmospheric. Unless otherwise specified, the tests shall be performed at $23^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$ at barometric pressure of 28 to 31 inches of mercury and a maximum relative humidity of 80 percent.

4.4.2 Operation. Unless otherwise specified, watches shall be operating during and following all tests.

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4.4.3 Accuracy. Unless otherwise specified, watches shall be accurate within ± 0.5 seconds per day before, during, and following the tests of 4.7 except for 4.7.4.5.

4.4.4 Test equipment. Accuracy of the watch shall be determined by a mechanical, electrical or electronic time measuring instrument having an accuracy of ± 0.033 seconds per day.

4.5 First article inspection. Unless otherwise specified in the contract or purchase order, the first article inspection shall consist of all the tests listed in 4.7 and Table I.

4.5.1 Samples. Six watches shall be subjected to first article inspection. The watches shall be manufactured in the same manner, using the same materials, equipment, processes and procedures as used in regular production.

4.6 Quality conformance inspection. Quality conformance inspection shall consist of sampling inspections.

4.6.1 Sampling inspection. The watch shall be subjected to the sampling inspection specified in Table II.

4.6.1.1 Inspection lot. Unless otherwise specified by the contracting officer, inspecting lot size, formation and presentation of lots shall be in accordance with "Submission of Product" and "Drawing of Samples" specified in MIL-STD-105.

4.7 Methods of examination and test.

4.7.1 Examination of product.

4.7.1.1 Case. The case, internally and externally, shall be inspected visually and dimensionally to determine conformance with design and workmanship requirements of Section 3 and Figure 1.

4.7.1.2 Case back. The case back shall be inspected to insure conformance with Figure 6. Snap type backs will be removed, examined for alignment and presence of reference marks and replaced on the case, using the nonspecial tool specified by the manufacturer. Power cells will be removed and examined for positive markings and replaced, using the nonspecial tool specified by the manufacturer. With the case back removed, the module shall be examined for markings as specified in 3.3.2.

4.7.1.3 Display. The display shall be visually and dimensionally examined to determine conformance to the requirements of 3.3.4 and Figure 5 for the Type I display and Figure 3 for Types II and III display.

4.7.1.4 Module design. The watch shall be visually examined while operating under all modes to determine compliance with design specification in 3.3.4, 3.3.5, 3.3.6, and 3.3.7.

4.7.1.5 Finish. The case, spring bars and external control switches shall be visually examined for finish.

4.7.1.6 Identification. All numbers, names, and location of identification markings shall be inspected for compliance with Figure 6.

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TABLE I. FIRST ARTICLE INSPECTION.

Requirement	Requirement paragraph	Test paragraph(s)
Materials	3.2	4.7.1.1, 4.7.1.8, 4.7.2.1
Metal parts - external	3.2.1.1	4.7.2.1
Metal parts - internal	3.2.1.2	4.7.2.1
Radiation limit for Class A	3.2.2	4.7.2.2.2
General design	3.3.1	4.7.1.1
Module	3.3.2	4.7.1.2
Power	3.3.3	4.7.2.5, 4.7.3.1
External control switch	3.3.4	4.7.1.1, 4.7.1.4, 4.7.1.5
Time base	3.3.5	4.7.1.4
Logic memory	3.3.6	4.7.1.4
Autoranging chronograph	3.3.7	4.7.1.4
Water resistance/waterproof	3.3.8	4.7.4.6
Case design	3.3.9.1	4.7.1.1
Case face (crystal)	3.3.9.2	4.7.1.1, 4.7.4.10
Crystal strength	3.3.9.3	4.7.3.3
Finish	3.3.9.4	4.7.1.5, 4.7.2.1
Case back	3.3.9.5	4.7.1.2, 4.7.1.6, 4.7.2.1
Case bars	3.3.11	4.7.1.5, 4.7.3.2
Liquid crystal display light readout	3.3.12	4.7.2.1, 4.7.2.4
Digit dimensions	3.3.12.1	4.7.1.3

TABLE I. FIRST ARTICLE INSPECTION. - continued

Requirement	Requirement paragraph	Test paragraph(s)
Brightness and contrast	3.3.12.2	4.7.3.4
Light sources	3.3.12.3	4.7.3.5
Incandescent or electro-luminescent light source	3.3.12.3.1	4.7.2.2.1, 4.7.3.5, 4.7.3.6
Continuous self-luminous light source	3.3.12.3.2	4.7.3.5
Dark viewing	3.3.12.3.3	4.7.3.6
Synchronization	3.4.1	4.7.3.7
Accuracy	3.4.2	4.7.3.8.2
Magnetism	3.4.2.1	4.7.3.8.1
Setting and display sequences	3.4.3	4.7.3.9
External control switch activating pressure	3.4.3.1	4.7.3.10
External control switch damaging force	3.4.3.2	4.7.3.10
Vibration	3.5.1	4.7.4.1
Storage	3.5.2	4.7.4.2
High and low temperature cycling	3.5.3	4.7.4.3
Altitude	3.5.4	4.7.4.4
Shock	3.5.5	4.7.4.5
Salt resistance	3.5.6	4.7.4.8
Human perspiration resistance	3.5.7	4.7.4.9
Identification	3.6	4.7.1.6
Operating instructions	3.7	4.7.1.7
Workmanship	3.8	4.7.1.8

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TABLE II. SAMPLING INSPECTION.

Inspection method	Requirement paragraph	Inspection level of MIL-STD-105	AQL acceptance quality level
Module power drain (see 4.7.3.1)	3.3.3	S-4	1.5
Display contrast (see 4.7.3.4)	3.3.12	S-1	1.5
Accuracy/magnetism (see 4.7.3.8.1)	3.4.2.1	S-1	4.0
Accuracy/temperature (see 4.7.3.8.2)	3.4.2	S-1	4.0
Setting and display sequence (see 4.7.3.9)	3.3.5/ 3.3.6	S-1	1/
External control switch (see 4.7.3.10)	3.4.3.1/ 3.4.3.2	S-1	4.0
Vibration (see 4.7.4.1)	3.5.1	S-1	4.0
Storage temperature (see 4.7.4.2)	3.5.2	S-1	1/
High and low temperature cycling (see 4.7.4.3)	3.5.3	S-4	1/
Shock (see 4.7.4.5)	3.5.5	S-4	1/
Water resistance/water-proof (see 4.7.4.6)	3.3.8	S-4	1/

1/ If one or more samples fail, the lot represented by the sample shall be rejected.

4.7.1.7 Operating instructions. The operating instructions shall be inspected for compliance with 3.7.1.

4.7.1.8 Workmanship. Quality of workmanship consistent with industry standard practices shall be inspected during manufacture and on completed watches at the discretion of the Government to insure that watches are produced in accordance with 3.8.

4.7.2 Certification compliance.

4.7.2.1 Materials. Acceptance of materials shall be by certification.

4.7.2.2.1 Incandescent. Incandescent lamps shall be certified to be in compliance with the maximum power drain requirements of 3.3.12.3.1.

4.7.2.2.2 Self-luminous. The luminous material for Type I, Class A, and Types II and III, Class A, shall be tested as specified for timepieces in Part 32 of Title 10, Chapter I of the Code of Federal Regulations. Certification of compliance with the specific license (see 6.4) shall be provided for each lot of self-luminous glass capsules.

4.7.2.3 Strap. The strap shall be certified to be in conformance with MIL-S-46383, and of type/color specified in 3.3.10.

4.7.2.3.4 Liquid crystal display. The liquid crystal display shall be certified to have a service life of 50,000 operating hours and polarizer positions are in compliance with Figure 4.

4.7.3 Performance tests.

4.7.3.1 Module power drain test. The module shall be tested to insure that the current drain of the timekeeping portion together with the drain of the backlighting allows a minimum 12 months service life from the power cell. Current drain of the backlighting shall be taken as the drain caused by 5 seconds per day usage per year ($5 \times 365 = 1,825$ seconds per year). The module shall be measured with a current meter with the lamp off to determine the timekeeping (quiescent) current drain. The module shall then be measured with a current meter with the lamp on to determine the backlighting current drain. (Note: This step is not used on Class A self-luminous watches, or watches with a separate power cell for backlighting.) The results of the timekeeping (quiescent) current drain are added to the current drain contributed by the backlighting to obtain total power drain on the power cell. To allow sufficient latitude in available power, the capacity of the power cell as measured in milliamp-hours (ma hours), shall be derated by 20 percent to obtain the net power capacity of the power cell. The comparison of power drain from the module and backlighting (Type I, Class B, and Type III, Class B, watches only) to the power capacity of the derated power cell shall be made to insure that a minimum life of 12 months can be obtained from the power cell.

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Example: $65 \text{ ma-hour per year of power cell}$ $\times 80 \text{ percent derating of power cell by 20 percent}$
 $52 \text{ ma-hour per year capacity of power cell after derating}$

Step 2: $\text{power drain on power cell (timekeeping function (step a) + lamp function (step b))} = \text{total power drain/year (step c)}$

Step a: $0.005 \text{ ma (timekeeping current, quiescent)}$
 $\times 8760 \text{ hours per year drain}$

$43.80 \text{ ma-hours per year (timekeeping)}$

Step b: 15 ma (lamp)
 $\times 0.5 \text{ hour per year drain (1,825 seconds per year)}$
 $7.5 \text{ ma-hour per year (lamp)}$

Step c: $43.80 \text{ ma-hour per year drain (timekeeping)}$
 $+ 7.5 \text{ ma-hour per year drain (lamp)}$
 $51.30 \text{ total ma-hour per year drain}$

Step 3: Comparison of derated power cell versus total drain (positive value indicates that the power cell will last a minimum of 1 year)

$52 \text{ ma-hour per year (derated power cell)}$
 $- 51.30 \text{ ma-hour per year (total drain)}$
 $+ 0.70 \text{ margin}$
 1 Power cell rating obtained from manufacturer's specification.

4.7.3.2 Case bar test. With the watch in a secured position and the strap held in a position that will not exert pressure on the buckle or the keeper of the strap, a pulling force of $15 \pm 1/2$ pounds, shall be applied to each case/spring bar via the strap without the case/spring bar permanently bending, loosening or causing other damage to the case/spring bar or case assembly.

4.7.3.3 Crystal strength test. After assembly to the case, the case assembly, including crystal, shall be placed flat, crystal up, on a horizontal, rigid, nonresilient, metal surface. A solid steel sphere weighing 0.56 ± 0.05 ounces (approximately 5/8 inch diameter) shall then be freely dropped so as to fall 40 inches ± 1 inch, before striking the crystal. The ball shall be dropped twice on each crystal, once so as to strike within 1/8 inch of the center, and once so as to strike within 1/8 inch of the periphery. Any visible damage to the crystal shall be cause for rejection.

4.7.3.4 Display contrast. The contrast ratio of the liquid crystal display shall be measured in foot-lamberts with a photometer under uniform diffused illumination. The contrast ratio of the digits in relation to the background shall conform to the requirements of 3.3.12.2. The term "contrast

ratio" refers to the ratio of the intensity of reflected light as measured by a photometer focused on a portion of a segment of the display when voltage across the segment is in phase ("off" condition) as compared to when the voltage across the segment is out of phase ("on" condition). The measurement is made at a viewing angle of 30° from the normal of the display at the position of 7:00 o'clock of a standard analog clock face dial (135 degrees counter clock-wise from the 12:00 o'clock position). The contrast ratio will be the average of 3 readings taken under each condition specified in 3.3.12.2.

4.7.3.5 Brightness test of backlight. The brightness of the backlight shall be tested on completed watches and measured in foot-lamberts with a photometer in a totally darkened area. Watches used for this test and the dark viewing test (see 4.7.3.6) shall have been kept in total darkness for a minimum of 8 hours prior to the test. The measurement is made at a viewing angle of 0° from the normal display. Watches with an incandescent or electroluminescent light shall be measured to insure compliance with the minimum overall diffused luminosity of 0.03 foot-lamberts. Type I, Class A, and Types II and III, Class A, watches shall have a maximum brightness of 0.05 foot-lamberts. There is no maximum brightness limit of Class B watches providing the watches pass the dark viewing test in 4.7.3.6.

4.7.3.6 Dark viewing test. Visibility of the liquid crystal display shall be tested in a totally darkened area by an observer using either the incandescent backlighted or self-luminous watches to read the time with the watch a minimum of 12 inches from the eyes of the observer. The test watches shall have been kept in total darkness for a minimum of 8 hours prior to this test.

4.7.3.7 Synchronization test. With any convenient hour or minute set on the timepiece, the synchronization of hours, minutes and seconds shall be checked. The hour and/or minute shall change in synchorization with seconds within ± 0.5 seconds. It shall be possible to set the watch to an accurate time reference to an accuracy of ± 1 second.

4.7.3.8 Accuracy tests.

4.7.3.8.1 Magnetism. The timekeeping of the watch shall not be affected when subjected for 10 minutes to a magnetic field of 125 gauss ± 1.00 gauss in any direction.

4.7.3.8.2 Temperature. After completion of all tests, except shock and water resistance, the mean daily rate (see 6.3.3) shall not exceed the following values at the temperatures specified in 3.4.2. The watches shall be subjected to the test temperature for at least 4 hours prior to the test.

<u>Temperature</u>	<u>Mean daily rate (seconds per day)</u>
$+1^\circ \pm 2^\circ\text{C}$	3
$+26^\circ \pm 2^\circ\text{C}$	0.5
$+40^\circ \pm 2^\circ\text{C}$	3

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4.7.3.9 Setting and display sequence test. Utilizing the watch setting and operating instructions provided (see 3.7), the watch shall operate in all logic modes specified in 3.3.5 and 3.3.6.

4.7.3.10 External control switch test. The force required to activate the external control switches shall be measured to insure a minimum force of 3.5 ounces and a maximum force of 10.6 ounces for Types I, II, and III watches. Type II watches shall be observed during the water resistance test 4.6.4.6 to insure that the external control switches do not activate when subjected to a water pressure of 75 pounds PSI. With a force of 4.75 ± 0.25 pounds applied to the external control switches, the watch shall be visibly examined to insure that no malfunctioning occurs, such as digits flashing, digits blanking out, or the wrong mode appearing for that specific external control switch. Such malfunctions shall be cause for rejection.

4.7.4 Environmental tests.

4.7.4.1 Vibration. While running, the watch shall be subjected to Method 201 of MIL-STD-202 for 30 minutes in each of the following directions:

- Perpendicular to display.
- Through the top and bottom of the display.
- Through the right and left sides of the display.

4.7.4.2 Storage temperature. After being subjected to the temperatures below and returned to room temperature, the watch shall be examined to insure that no damage has occurred to the power cell or liquid crystal display which affects the readability of the display:

- $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 24 hours

- $+60^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 24 hours

4.7.4.3 High and low temperature cycling test. This 6 hour test of subjecting the watch to high and low temperatures of 60 minutes at $+5^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 60 minutes at $+41^{\circ}\text{C} \pm 2^{\circ}\text{C}$ shall determine the quality of bonding materials used within the module and reliability of the liquid crystal display. The watch shall be subjected alternately to each temperature variation for periods of 60 minutes each for a total of 6 hours. During the temperature cycling, the liquid crystal display shall be observed to insure that the display does not blank out. Upon completion of the test, the watch shall be activated through all logic modes and observed to insure that the time base and chronograph are operating. The blanking out of any portion of the display or nonoperation of the timekeeping and chronograph stopwatch mode is cause for failure of the test.

4.7.4.4 Altitude. The watch shall be subjected to pressure equivalent to that experienced at 35,000 feet for 15 minutes without damage. The pressure shall be decreased from zero feet (sea level) to 35,000 feet within 2 minutes and held constant at 35,000 feet for a minimum of 15 minutes. Separation of the face crystal on case back shall be cause for rejection.

4.7.4.5 Shock. While running, the watch shall be dropped uncontrolled, with the strap removed, from a height of 2 1/2 feet onto the end grain of a beech, oak, or hard maple block, the size of which shall be a minimum of

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4 inches square by 4 inches thick. The watch, at the conclusion of the test, shall show no malfunctioning. The daily rate (see 6.3.2) after the test at $+26^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ in any position shall not exceed the requirements of 3.5.4.

4.7.4.6 Water resistance/waterproof. Prior to immersion in water, all external control switches shall be depressed a minimum of 10 times. The watch shall then be placed in a pressure vessel, in any position, with the watch running. The watch shall then be surrounded with distilled water and subjected to a pressure of 45 pounds PSI for 60 minutes. Type II watches shall be subjected to 75 pounds PSI for 60 minutes. After removal from water, the watch shall be subjected to a temperature of $+45^{\circ} \pm 1^{\circ}\text{C}$ for 30 minutes. After the test, the watch shall show no evidence of damage or condensation within the case.

4.7.4.7 Salt fog test. The watch shall be subjected to a salt fog test for 48 hours as specified in Method 509.1 of MIL-STD-810. Upon completion of the test, the watch shall be rinsed and allowed to dry for 48 hours prior to examination. The watch shall show no evidence of excessive salt deposits or corrosion which affects the operation of the external control switches, viewability of the display, or evidence of base metal corrosion.

4.7.4.8 Human perspiration resistance. This accelerated test is designed to determine porosity and resistance to corrosion by skin chemicals, or their equivalents. The test shall be conducted as follows:

a. The watch shall be immersed for a period of 3-5 seconds in a concentrated (saturated) sodium chloride solution, containing a 5 percent volume of lactic acid (65 percent strength) at a temperature of $91^{\circ}\text{C} \pm 2^{\circ}\text{C}$. (Note: This high temperature allows the rapid flash off of water.)

b. The watch shall be suspended in an air-tight chamber (desiccator) for 20 hours, in a vapor produced by 100 milliliters of a 50 percent solution of acetic acid in water, in a small open container.

c. Upon completion of this 20-hour test, the watch shall show no evidence of base metal corrosion (slight staining is permitted).

4.7.4.9 Crystal. The crystal, after the environmental tests of 4.7.4 shall be visually examined for any imperfections, as listed in 3.3.9.2, which would interfere with reading of the watch, and shall show no evidence of scratches or gouges.

5. PACKAGING

5.1 Preservation - packaging. Each watch shall be preserved and packaged in accordance with the normal commercial practice of the manufacturer for commercially marketed watches. The complete package shall be designed to protect the item during shipment, handling and storage. The operating instructions (see 3.7) shall be included in each unit package.

5.2 Marking. The unit package, intermediate package and shipping container shall be marked with the date of acceptance by the Government and any markings specified in the contract.

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6. NOTES

6.1 Intended use. The watches covered by this specification have intended application as follows:

Type I	24 hour	General purpose with stopwatch
Class A		For use in all types of duty
Class B		For use in combat or field environments where self-luminous lighting is not desirable or radioactive material is not allowed
Type II	24 hour	For use by divers in depths up to 165 feet below sea level
Type III	24 hour	For use by aircrew members, navigators, and shallow water divers in depths up to 100 feet below sea level
Class A		For use in all types of duty where radioactive material is not prohibited
Class B		For use in duty where radioactive material is prohibited, e.g., navigators on nuclear-powered ships

6.2 Ordering data. Procurement documents should specify the following:

- Title, number, and date of this specification.
- Type and class of watch required for Types I and III watches.
- Identification of agency (U. S. Government or contractor) which will perform first article testing (if required).
- Applicable national stock number.
- Marking requirements for preservation and packing. The outside container for each watch shall be marked: "Store at temperatures not lower than -20°C or higher than +60°C."
- Specification as to whether watches shall include or exclude power cell(s). NOTE: It is recommended that watches purchased for long-term storage (over 18 months) should not be equipped with power cell(s).

6.3 Definition of terms used.

6.3.1 Rate. Rate is the error, in seconds, between any two readings of the watch.

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6.3.2 Daily rate. The term "daily rate" is used synonymously with the terms "daily error" and "daily accuracy."

6.3.3 Mean daily rate. Mean daily rate is the arithmetic average of the individual daily rates (daily errors) with proper regard to algebraic signs in the summation. Unless otherwise specified, the mean daily rate shall be computed using three consecutive days' operation.

6.3.4 PSI. Pounds per square inch.

6.3.5 Atmosphere. One atmosphere equals 14.7 PSI, absolute, at sea level or the pressure exerted at 33.86 feet below sea level at 39.2°F (4°C).

6.4 Luminous material. Prospective bidders shall be cognizant of the need for a license as required in Parts 30 and 32 of Code of Federal Regulations, Title 10, as referenced in 2.2.

6.5 Warranty (3.7.1 f). Watches shall be warranted for performance in accordance with the requirements of this specification for a period of 1 year after acceptance by the Government. The warranty shall not be binding on watches which have been subjected to conditions in excess of the requirements of this specification or have been adjusted or repaired by persons other than factory authorized repair service. Within the warranty period, the necessary repairs to or replacement of a watch satisfying the warranty requirements shall be accomplished by the contractor at no cost to the Government, except that the Government shall bear the expense of shipping the watches to the contractor and of their return to the Government.

6.6 Reclaimed materials. Reclaimed materials shall be used to maximum extent possible.

Custodian:

Air Force - 99
Army - AR
Navy - SH

Preparing activity:

Air Force - 99

Civil Agency Interest:

Review activity:

GSA-FSS

Navy - OS, AS
DSA - GS

User activity:

(Project No 6645-0336)

Army - ME, ER
Navy - NM, CG

