OCEAN ENGINEERING DIVISION

UNITED STATES COAST GUARD

WASHINGTON, D.C.

MARCH 2003

SPECIFICATION FOR

PHOTORESISTORS FOR SOLID-STATE FLASHERS

SPECIFICATION NO. G-SEC-234E

1 SCOPE

1.1 Purpose: This specification provides the requirements for photoresistors used with solid-state flashers to daylight control lighted marine aids to navigation.

1.2 Deliverables: This specification gives the requirements for the following items:

a. Type C photoresistor, for use in clear and yellow acrylic and glass lenses;
b. Type R photoresistor, for use in red and green acrylic lenses; and
c. Type L photoresistor, for use external to the lens.

2 APPLICABLE DOCUMENTS

2.1 General: The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government Documents:

2.2.1 Specifications, Standards and Handbooks: The following specifications, standards and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those listed in the GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, of the DOD Index of Specifications and Standards (DODISS), and supplements thereto, cited in the solicitation.

STANDARDS

MILITARY:	MIL-STD-202F 1 April 1980	Test Methods for Electronic and Electrical Component Parts.

Unless otherwise indicated, copies of this document are available as stated in the solicitation/ contract clauses stating availability of specifications and standards listed in the GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, and the DOD Index of Specifications and Standards (DODISS).

SPECIFICATIONS

U.S.C.G.:	G-SEC-493A June 2000	12VDC Solid State Programmable Flasher for Maritime Aids to Navigation.

Unless otherwise indicated in the solicitation/contract, copies of this document are available from Commandant (G-SEC-2), U.S. Coast Guard, 2100 2nd Street, SW, Washington, DC, 20593-0001.

2.3 Non-Government Documents and Publications: The following non-government documents form a part of this specification to the extent specified herein.

ANSI/ASQC Z1.4-1993	Sampling Procedures and Tables For Inspection by Attributes

Application for copies of this document should be addressed to American Society for Quality (ASQ), 600 North Plankinton Avenue, Milwaukee, WI 53203 (E-Mail: help@asq.org).

2.4 Drawings:

G-EOE-SK 1393 May 1985	Photoresistor, Flasher Mounted
G-EOE-SK 1394 May 1985	Photoresistor, Remotely Mounted

Unless otherwise indicated in the solicitation/contract, copies of this drawings are available from Commandant (G-SEC-2), U.S. Coast Guard, 2100 2nd Street, SW, Washington, DC, 20593-0001.

2.5 Precedence: In the event of a conflict between the text of this document and the references cited herein, 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 Approval: The items furnished under this specification shall be products that have previously passed all First Article Tests (FAT) and, hence, become approved for Coast Guard use prior to contract award (see 4.2).

3.2 Mechanical: Photoresistors shall be constructed as shown in G-EOE drawings SK 1393 (Type C and Type R) and SK 1394 (Type L), as appropriate.

3.2.1 Photoresistive Material: The photoresistive material shall be cadmium sulfide (CdS) with a spectral response that approximates the human eye. The CdS may have active constituents such as selenium and silicon to change the spectral response of pure CdS.

3.2.2 Potting Material: A hard potting material shall be used as shown in G-EOE drawings SK 1393 and SK 1394. The potting material shall be compatible with the photoresistive cell, case, pipe plug, mounting lugs and insulated wire. When cured the hard potting material shall support all parts of the photoresistor as a rigid unit except for that section of the leads that extend beyond the limits of the potting material. The plastic case of the photoresistor shall be filled so that a minimum of ⅛ inch of the insulation of the photoresistor leads and the soldered joint are completely encapsulated, as indicated in G-EOE drawings SK 1393 and SK 1394. In addition, the case shall be filled to within at least $^{1}/_{32}$ inch of the end from which the leads protrude.

3.2.3 Plastic Case: The plastic case used for Type C and Type R photoresistors shall be made of color-impregnated plastic; white for Type C and red for Type R. The dimensions of the case shall conform to G-EOE drawing SK 1393. A ¾-inch NPT-type pipe plug shall be used as the case for Type L photoresistors. It shall be made of rigid polyvinyl chloride, acetal resin or similar plastic. The dimensions of the pipe plug shall conform to G-EOE drawing SK 1394. The pipe plug shall be dark blue, dark gray, or black in color.

3.2.4 Encapsulant: To help maintain environmental integrity and prevent saltwater from entering and damaging the CdS cell, a clear encapsulant shall be applied to the external surface of each photoresistor's photosensitive "eye" to seal off any possible water ingress points in this area. The encapsulant shall be applied as a liquid but shall cure to form a permanent thin gel-like conformal coating of the entire photosensitive "eye" area. Once applied and cured, the encapsulant shall be uv-stable and shall not degrade or become discolored, translucent, or opaque over time affecting the photometric performance of the photoresistor.

3.2.5 Terminals and Wires: Terminals and wires shall comply with G-EOE drawings SK 1393 and SK 1394, as appropriate.

3.2.6 Identification and Marking: Identification and marking of photoresistors shall be as specified in the applicable purchase order or contract.

3.3 Electrical:

3.3.1 Spectral Response: The photoresistor shall have a peak spectral response between 520 and 650 nanometers (nm). The spectral response for any point outside the 490 to 700 nm region shall not exceed 50% of the peak response.

3.3.2 Resistance: Resistance values for the photoresistors are based on exposure to a CIE standard illuminant D_{65}, with a color temperature 6500K. Cutoff filters shall eliminate the luminous output of the source for wavelengths above 770 nm and below 320 nm to ensure that the photoresistive response approximates the spectral response of the human eye. The required resistance values for the different types of photoresistors are outlined in Table 1, below:

Table 1—Photoresistor response at specified luminance values.

Photoresistor	Resistance (kΩ) at 2 ft-cd	Resistance (kΩ) at 40 ft-cd
Type C	129.0	10.8
Type R	49.0	4.10
Type L	129.0	10.8

3.3.3 Power Dissipation: The photoresistor shall be able to dissipate 125 milliwatts at ambient temperatures ranging from -10°F to +140°F.

3.4 Environmental: Each photoresistor shall operate as specified in the following environments.

3.4.1 Temperature: In ambient temperatures ranging from -10°F to 140°F.

3.4.2 Humidity: In environments with 0% to 100% relative humidity.

3.4.3 Water: After being totally submerged to a depth of not less than one foot under seawater for one hour.

3.4.4 Salt Spray: When exposed to sea and salt spray, except in the occurrence that the window of the photoresistive cell is totally covered with dried salt. The photoresistor shall continue to work correctly when the photoresistive cell is cleaned.

3.4.5 Shock and Vibration: Able to withstand the vibrations and shocks occurring in shipping to, installation on, and service at lighted navigational buoys.

3.5 Government Furnished Property (GFP): None.

4 VERIFICATION

4.1 Classification of Inspections: The inspections requirements specified herein are classified as follows:

a. First Article Tests (FAT) for approval (section 4.2 and 4.5); and
b. Conformance inspection (section 4.3).

4.2 Approval Testing: Six (6) samples of each type of photoresistor shall be submitted for the first article tests (FAT) and inspection for approval. This inspection and testing shall include the examination of 4.4 and the tests of 4.5.1 through 4.5.5.

4.3 Conformance Inspection: A random sample of photoresistors (the number and type to be specified by ANSI/ASQC Z1.4, Table IIA, based on General Inspection Level II from Table I) shall be selected from each production lot. A production lot shall be all of the photoresistors from an identifiable production period from one manufacturer and one plant and submitted for acceptance at one time. Conformance inspection shall consist of the examinations of 4.4 and the inspection and tests of 4.5.3.

4.4 Examination: Each photoresistor in the sample lot shall be examined to verify conformance to dimensions and workmanship as stated in drawing SK 1393 or SK 1394, as appropriate, and section 3.2, above. A photoresistor that fails to comply with any of the mechanical requirements (material selection and color, dimensions, etc.) of this specification or has any defects that will interfere with its use or decrease its life expectancy is deemed a failure. Lots in which the percent nonconforming is in excess of ANSI/ASQC Z1.4, AQL = 0.65 shall not be accepted.

4.5 First Article Tests (FAT):

4.5.1 Mechanical Conformance Test: One photoresistor of each type shall be longitudinally sectioned to check for proper interior workmanship and dimensions. It shall not be subject to further testing.

4.5.2 Spectral Response: The relative spectral response of each photoresistor shall be

measured at intervals of 20 nm or less, over the range of 320 nm through 770 nm, to insure compliance with 3.3.1. Failure of any photoresistor to conform to the requirements of 3.3.1 shall be reason for not approving that type of photoresistor.

4.5.3 Electrical Resistance: The photoresistors shall be light adapted for 16 ±2 hours at 30 ±5 foot-candle illumination at an ambient temperature of 70° ±10°F. The illuminant for light adapting shall be fluorescent lights that are industry designated to emit cool white, warm white or daylight light. Place the photoresistors in series with a digital ammeter and a 20VDC ±1% voltage source. Measure the electrical resistance of each photoresistor to insure compliance with 3.3.2, with a tolerance of ±50%. The measurements shall be made while the photoresistor is illuminated by a diffuse CIE Standard Illuminant D_{65} at illumination levels of 2 and 40 foot-candles (±3%). The requirements for the Standard Illuminate D_{65} are described in section 6. Failure of any photoresistor to conform to the requirements of 3.3.2 shall be reason for not approving that type of photoresistor. For conformance inspection, lots in which the percent nonconforming is in excess of ANSI/ASQC Z1.4, AQL = 0.65 shall not be accepted.

4.5.4 Power Dissipation: Place one sample of each type of photoresistor in a hot chamber maintained at 140°F ±2°F. Connect the photoresistor in series with a digital ammeter and a 20 VDC ±1% voltage source. Illuminate the photoresistor such that it conducts 6.2 milliamperes ±0.2 milliamperes. Maintain the photoresistor in this conducting mode for ten minutes. Remove the photoresistor and allow it to cool for at least one hour. Complete an electrical resistance test (4.5.3.) on the photoresistor. Failure of the photoresistor to conform to the requirements of 3.3.2 after the power dissipation test shall be reason for not approving that type of photoresistor.

4.5.5 Environmental Tests: Each photoresistor shall be subjected to the environmental tests listed below, in the same order as listed below.

4.5.5.1 Vibration: The samples shall be tested in accordance with MIL-STD-202F, Method 204D, using Test Condition D, with the duration reduced to three cycles (each cycle to be 20 minutes long) and the amplitude to 10 G in each of the three mutually perpendicular directions. Type C and Type R photoresistors shall be attached to a rigid fixture capable of transmitting all the vibration conditions by means of terminal strips sized to hold the rigid daylight control spade lug. The Type L daylight control shall be attached by clamping the pipe plug firmly in place or by screwing it in to a rigid threaded female connection.

4.5.5.2 Shock: The samples shall be tested in accordance with MIL-STD-202F, Method 213B, Test Condition H. The samples shall be rigidly mounted to terminal strips sized to hold the rigid photoresistor spade lug. The Type L daylight control shall be attached by either clamping the pipe plug firmly in place or by screwing it in to a rigid threaded female connection.

4.5.5.3 Immersion (seal): The samples shall be immersed in salt water at a depth of 12" ± 1" for one hour. The salt solution shall be as described in MIL-STD-202F, Method 101D. After immersion the samples shall be allowed to drain for one hour and shall then be washed with fresh water and wiped or air-blasted dry.

4.5.5.4 Salt-Spray (corrosion): The samples shall be tested in accordance with MIL-STD-202F using Method 101D, Test Condition B. After exposure the exterior of the samples shall be

thoroughly inspected for evidence of susceptibility to corrosion.

4.5.5.5 Moisture Resistance: The samples shall be tested in accordance with MIL-STD-202F, Method 106F. The procedure is modified as follows:

a. Omit the initial measurements described in paragraph 3.2 of the test;
b. Step 7a shall be performed during the third through the seventh cycles of the test;
c. Eliminate step 7b of the test;
d. No voltage shall be applied to the photoresistors during the test; and
e. No final measurements shall be made under this test.

4.5.5.6 Final Measurements: At the conclusion of 4.5.5.5 the photoresistors shall be wiped or air-blasted dry and visually inspected for any signs of corrosion, color fading of the plastic case, or moisture in the photoresistive cell. Evidence of corrosion, or color fading of the case, or moisture entering the photoresistive cell shall be deemed a failure of an individual photoresistor. Failure of two photoresistors, of any single type of photoresistor, shall be reason not to approve that type of photoresistor. The photoresistors shall then be light adapted and subjected to the electrical resistance test (4.5.3) at equilibrium temperatures of -10°F ±2°F and +70°F ±10°F. Three failures (out of twenty measurements—five each photoresistors X two temperatures X two light levels each) to meet the requirements of 3.3.2 shall be cause not to approve that type of photoresistor.

5 PREPARATION FOR DELIVERY

5.1 Packaging, Packing and Marking: The requirements for packaging, packing and marking shall be as specified in the Contract or Purchase Order.

6 NOTES

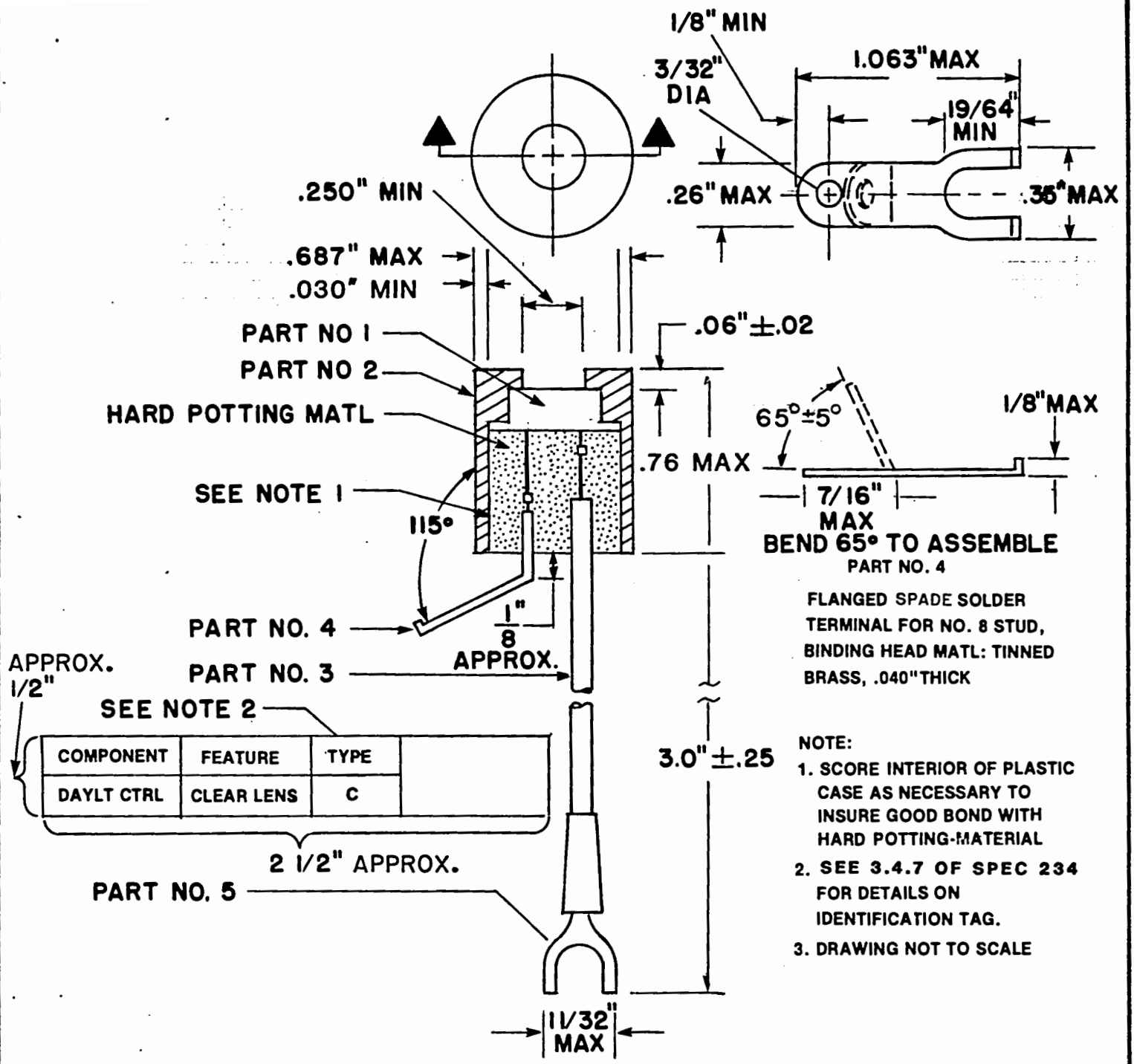
6.1 Standard Illuminant D_{65}: The relative spectral irradiance distribution curve for the source which is used shall match the defined curve for the CIE standard illuminant D_{65} such that the square root of the mean square deviation is less than 20% over the wavelength range 320 nm to 770 nm, with the sample points measured at 10 nm intervals. This is mathematically described by:

$$\left(\frac{1}{46} \sum_{\lambda=320nm}^{770nm} [D(\lambda) - f * S(\lambda)]^2 \right)^{1/2} \leq 20\%$$

where: $D(\lambda)$ = spectral irradiance of C.I.E. standard illuminate D_{65};
$S(\lambda)$ = spectral irradiance measured for the source used; and
f = scaling factor constant, defined as:

$$f = \frac{\sum_{\lambda=320nm}^{770nm} S(\lambda) * D(\lambda)}{\sum_{\lambda=320nm}^{770nm} S^2(\lambda)}$$

6.1.1 Cutoff Filters: Cutoff filters shall be used to eliminate the luminous output of the source for wavelengths below 320 nm and above 770 nm.



COMPONENT	FEATURE	TYPE	
DAYLT CTRL	CLEAR LENS	C	

PART NO. 4

FLANGED SPADE SOLDER TERMINAL FOR NO. 8 STUD, BINDING HEAD MATL: TINNED BRASS, .040"THICK

NOTE:

1. SCORE INTERIOR OF PLASTIC CASE AS NECESSARY TO INSURE GOOD BOND WITH HARD POTTING-MATERIAL
2. SEE 3.4.7 OF SPEC 234 FOR DETAILS ON IDENTIFICATION TAG.
3. DRAWING NOT TO SCALE

PARTS LIST	
PART - 1	PHOTORESISTIVE CELL
PART - 2	PLASTIC CASE
PART - 3	TYPE MW, EXTRA FLEXIBLE STRANDED COPPER WIRE WITH 80° C YELLOW PVC INSULATION, AWG SIZE 18
PART - 4	FLANGED SPADE, DETAIL TOP RIGHT
PART - 5	SPADE SOLDERLESS TERMINAL FOR NO.8 STUD, BINDING HEAD (AMP NO. 325199, AEROVOX NO. 50191 -1 OR EQUAL "TINNED ELECTROLYTIC COPPER"

REV.	DATE	APPR	DESCRIPTION	BY
(A)			REDRAWN	

DE: R.W.T.
DR:
TR: W.T.W
CH:
REVIEWED BY: R.E. Gearhard
CH A&O SEC
REVIEWED BY: D.W. Leppert
CH SIG. BR
SCALE: 2/1

U.S. COAST GUARD HEADQUARTERS
OCEAN ENGINEERING

PHOTORESISTOR
FLASHER MOUNTED

APPROVED: [signature] DATE: 7/1/68
CHIEF OF DIVISION

SHEET 1 OF 1 DR. NR. EOE SK.1393

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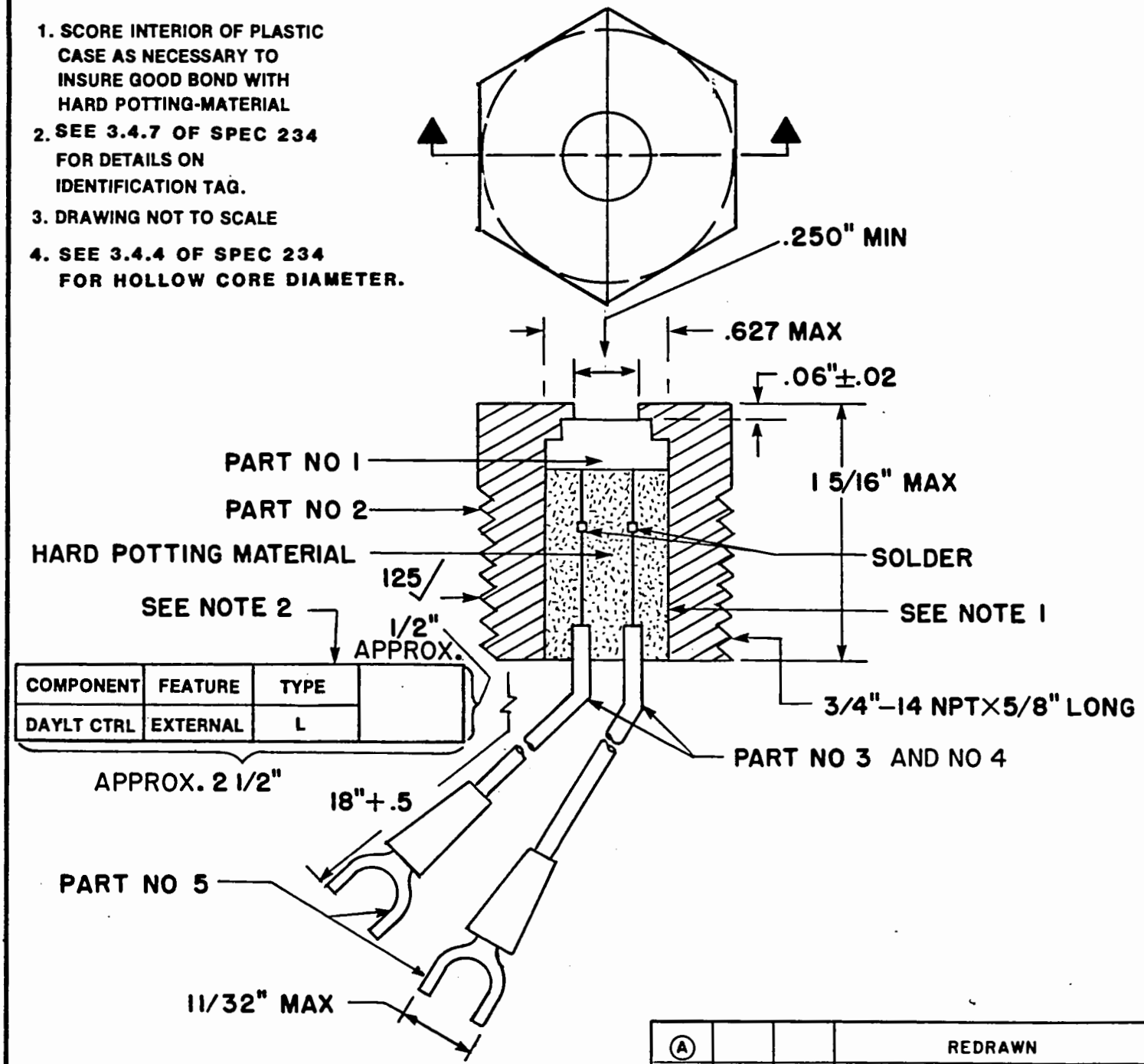
1. SCORE INTERIOR OF PLASTIC CASE AS NECESSARY TO INSURE GOOD BOND WITH HARD POTTING-MATERIAL
2. SEE 3.4.7 OF SPEC 234 FOR DETAILS ON IDENTIFICATION TAG.
3. DRAWING NOT TO SCALE
4. SEE 3.4.4 OF SPEC 234 FOR HOLLOW CORE DIAMETER.



COMPONENT	FEATURE	TYPE
DAYLT CTRL	EXTERNAL	L

PARTS LIST	
PART - 1	PHOTORESISTIVE CELL
PART - 2	UPVC OR ACETAL RESIN PIPE PLUG 3/4 " NPT
PART - 3&4	TYPE MW, EXTRA FLEXIBLE STRANDED COPPER WIRE WITH 80° C YELLOW PVC INSULATION, AWG SIZE 18
PART - 5	SPADE SOLDERLESS TERMINAL FOR NO.8 STUD, BINDING HEAD (AMP NO. 325198. AEROVOX NO. 50191 -1 OR EQUAL "TINNED ELECTROLYTIC COPPER"

REV	DATE	APPR.	DESCRIPTION	BY
(A)			REDRAWN	

DE. R.W.T.
DR:
TR: W.T.W.
CH:
REVIEWED BY: J. Gunderson
CH A&O SEC
REVIEWED BY:
CH. SIG. BR.
SCALE: 2/1

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PHOTORESISTOR
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CHIEF OF DIVISION
DATE 7-7-76

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SPECIFICATION FOR

PHOTORESISTORS FOR SOLID-STATE FLASHERS

SPECIFICATION NO. G-SEC-234E

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8 APR 03

Date: