NOTE: The document identifier and heading has been changed on this page to reflect that this is a performance specification. There are no other changes to this document. The document identifier on subsequent pages has not been changed, but will be changed the next time this document is revised.

INCH-POUND

MIL-PRF-23648D
4 April 1995
SUPERSEDING
MIL-T-23648C
17 August 1992

PERFORMANCE SPECIFICATION

# RESISTOR, THERMAL (THERMISTOR) INSULATED, GENERAL SPECIFICATION FOR

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

## 1. SCOPE

1.1 Scope. This specification covers the general requirements for general purpose insulated thermal resistors to be used for temperature compensation, control, and measurement over the temperature range specified (see 3.1).

1.2 Classification.

1.2.1 Part or Identification Number (PIN). The PIN shall be in the following form and as specified (see 3.1 and 6.1).

| RTH06 | A | S | 102 | G |
|---|---|---|---|---|
| Style (1.2.1.1) | Resistance ratio characteristic (1.2.1.2) | Lead type (1.2.1.3) | Zero-power resistance (1.2.1.4) | Zero-power resistance tolerance (1.2.1.5) |

1.2.1.1 Style. The style is identified by the symbol RTH followed by a two digit number. The letters identifies general purpose thermal resistors and the number identifies the physical configuration.

1.2.1.2 Resistance ratio characteristic. The characteristic is identified by a one-letter symbol in accordance with table I.

TABLE I. Resistance ratio characteristic.

| Symbol | Resistance ratio characteristic |
|---|---|
| A | 19.8 ±10 percent |
| B | 29.4 ±10 percent |
| C | 48.7 ±10 percent |
| D | 0.5 ±10 percent |
| E | 0.55 ±10 percent |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAM, Post Office Box 3990, Columbus, OH 43216-5000 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5905

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1.2.1.3 Lead type. Resistor lead types are identified as solderable (type S) or weldable (type W), (see 3.3.1).

1.2.1.4 Zero-power resistance. The direct current (dc) zero-power resistance measured at 25°C and expressed in ohms is identified by a three-digit number. The first two digits represent significant figures, and the last digit specifies the number of zeros to follow. The standard resistance values for every decade shall follow the sequence demonstrated for the "10 to 100" decade in table II. Resistance values not listed shall be considered as not conforming to the specification.

Examples: 101 = 100 ohms
102 = 1,000 ohms
103 = 10,000 ohms
105 = 1 megohm

TABLE II. Standard resistance values for the 10 to 100 decade.

| 5.0 | 10.0 | 20.0 | 5.0 | 10.0 | 20.0 |
|---|---|---|---|---|---|
| 10.0 | 10.0 | 10.0 | 33.0 | 33.0 | 33.0 |
| 11.0 | .... | .... | 36.0 | .... | .... |
| 12.0 | 12.0 | .... | 39.0 | 39.0 | .... |
| 13.0 | .... | .... | 43.0 | .... | .... |
| 15.0 | 15.0 | 15.0 | 47.0 | 47.0 | 47.0 |
| 16.0 | .... | .... | 51.0 | .... | .... |
| 18.0 | 18.0 | .... | 56.0 | 56.0 | .... |
| 20.0 | .... | .... | 62.0 | .... | .... |
| 22.0 | 22.0 | 22.0 | 68.0 | 68.0 | 68.0 |
| 24.0 | .... | .... | 75.0 | .... | .... |
| 27.0 | 27.0 | .... | 82.0 | 82.0 | .... |
| 30.0 | .... | .... | 91.0 | .... | .... |

1.2.1.5 Zero-power resistance tolerance. The zero-power resistance tolerance is identified by a single letter in accordance with table III.

TABLE III. Resistance tolerance versus temperature for each resistance tolerance.

| Sequence | Temperature | F ± percent | G ± percent | J ± percent | K ± percent |
|---|---|---|---|---|---|
| 1 | -55 | 1/ 10 (15) | 1/ 12 (17) | 1/ 15 (20) | 1/ 20 (25) |
| 2 | -15 | 1/ 5 (9) | 1/ 6 (10) | 1/ 9 (13) | 1/ 14 (18) |
| 3 | 0 | 3 | 4 | 7 | 12 |
| 4 | 25 | 1 | 2 | 5 | 10 |
| 5 | 50 | 3 | 4 | 7 | 12 |
| 6 | 75 | 5 | 6 | 9 | 14 |
| 7 | 100 | 7 | 9 | 12 | 17 |
| 8 | 125 | 10 | 12 | 15 | 20 |
| 9 | 2/ 200 | 15 | 18 | 25 | 30 |
| 10 | 2/ 275 | 20 | 25 | 35 | 40 |

1/ The percentages in parentheses are for positive temperature coefficient thermistors.
2/ These temperatures not applicable to all styles (see 3.1).



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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 6.1).

SPECIFICATIONS

MILITARY

MIL-R-39032 - Resistors, Packaging of.

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Components Parts.
MIL-STD-1276 - Leads for Electronic Component Parts.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.

* (Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robins Avenue, Philadelphia, PA 19111-5094).

* 2.1.2 Non-Government publications. The following document forms 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 6.1).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NCSL Z540-1-1994 - General Requirements for Calibration Laboratories and Measuring and Test Equipment

(Application for copies should be addressed to the American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B545 - Standard Specification for Electrodeposited Coating of Tin.

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(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.)

* 2.2 Order of precedence. In the event of conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), 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 Associated detail specifications. The individual part requirements shall be as specified herein and in accordance with the applicable associated detail specification. In the event of any conflict between the requirements of this specification and associated detail specification the latter shall govern.



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* 3.2 Qualification. Thermistors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) at the time of award of contract (see 4.4 and 6.2). Not applicable when specified (see 3.1).

3.3 Design and construction. The resistors shall be of the design, construction, and physical dimensions specified (see 3.1). Resistors shall be constructed so as to provide protection against exposure to humidity and temperature conditions by means of an enclosure or a coating of moisture resistance insulating material.

3.3.1 Terminals.

3.3.1.1 Type S (solderable). All type S terminals shall be suitably treated to facilitate soldering. Their dimensions shall conform to the detail requirements (see 3.1).

3.3.1.2 Type W (weldable). Type W terminals smaller than 0.005 inch nominal diameter shall be platinum or platinum iridium alloy. Larger leads shall be materials specified in MIL-STD-1276. Dimensions shall conform to the detail requirements (see 3.1).

3.3.1.3 Solder dip (retinning) leads. The manufacturer may solder dip/retin the leads of product supplied to this specification provided the solder dip process has been approved by the qualifying activity. The manufacturer shall maintain a solder purity in accordance with table IV, during the tinning process.

3.3.1.3.1 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

a. When original lead finish qualified was hot solder dip lead finish 52 of MIL-STD-1276. (NOTE: The 200 microinch maximum thickness is not applicable.) The manufacturer shall use the same solder dip process for retinning as is used in the original manufacture of the product.

b. When the lead originally qualified was not hot solder dip lead finish 52 of MIL-STD-1276 as prescribed in 3.3.1.3.1a, approval for the process to be used for solder dip shall be based on the following test procedure:

(1) Thirty samples of any resistance value for each style and lead finish are subjected to the manufacturer's solder dip process. Following the solder dip process, the resistors are subjected to the zero-power resistance test and other group A electricals. No defects are allowed.

(2) Ten of the 30 samples are then subjected to the solderability test. No defects are allowed.

(3) The remaining 20 samples are subjected to the resistance to solder heat test followed by the moisture resistance test. No defects are allowed.

TABLE IV. Contamination limits.

| Contamination | Tinning percent by weight 1/ |
|---|---|
| Copper | 0.750 |
| Gold | 0.500 |
| Cadmium | 0.010 |
| Zinc | 0.008 |
| Aluminum | 0.008 |
| Antimony | 0.500 |
| Iron | 0.020 |
| Arsenic | 0.030 |
| Bismuth | 0.250 |
| Silver | 0.750 |
| Nickel | 0.250 |

1/ This is a fixed percentage by weight of the solder.



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3.3.1.3.2 Solder dip/retinning options. The manufacturer may solder dip/retin as follows:

a. After group A tests and following the solder dip/retinning process, the electrical measurements required in group A, subgroup 1, tests shall be repeated on the lot. Group A, subgroup 1, lot rejection criteria shall be used. Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in 4.6.4.

b. As a corrective action if the lot fails the group A solderability test.

3.3.2 Soldering flux. When soldering fluxes are required during the manufacturing process, noncorrosive fluxes shall be used unless it can be shown that the corrosive elements have been satisfactorily removed or neutralized after soldering.

* 3.3.3 Tin plated finishes. Use of tin plating is prohibited as a final finish and as an undercoat (see 6.8.1). Use of tin-lead (Sn-Pb) finishes are acceptable provided that the minimum lead content is 3 percent.

3.4 Zero-power resistance. Each resistor shall have a zero-power resistance value within the specified tolerance of the nominal resistance value specified (see 3.1 and 4.6.2).

3.5 Resistance ratio characteristic. The resistance ratio shall be as specified (see 3.1 and 4.6.3).

3.6 Solderability (if applicable) (see 3.1). When resistors are tested as specified in 4.6.4, the dipped surface of the leads shall be at least 95 percent covered with a new solder coating. The remaining 5 percent of the lead surface shall show only small pinholes or voids; these shall not be concentrated in one area. Bare base metal and areas where the solder dip failed to cover the original coating are indications of poor solderability, and shall be cause for failure. In case of dispute, the percent of coverage with pinholes or voids shall be determined by actual measurement of these areas, as compared to the total area.

3.7 Short time overload. When resistors are tested as specified in 4.6.5, resistors shall not arc, burn, char, or open circuit. The change in zero-power resistance shall not exceed the value specified (see 3.1).

3.8 Insulation resistance. When resistors are tested as specified in 4.6.6, the insulation resistance shall not be less than 500 megohms.

3.9 Dielectric withstanding voltage (unless otherwise specified (see 3.1)). When resistors are tested as specified in 4.6.7, there shall be no evidence of mechanical or electrical damage, arcing, or breakdown.

3.10 Low temperature storage. When resistors are tested as specified in 4.6.8, there shall be no evidence of mechanical damage and the change in zero-power resistance shall not exceed the value specified (see 3.1).

3.11 High temperature storage. When resistors are tested as specified in 4.6.9, the change in zero-power resistance shall not exceed the value specified (see 3.1).

3.12 Dissipation constant. When resistors are tested as specified in 4.6.10, the dissipation constant shall be as specified (see 3.1).

3.13 Thermal time constant. When resistors are tested as specified in 4.6.11, thermal time constant shall be as specified (see 3.1).

3.14 Terminal strength. When resistors are tested as specified in 4.6.12, resistors shall withstand the specified pull or twist without evidence of mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1).

* 3.15 Resistance temperature characteristics. When resistors are tested as specified in 4.6.13, the curve obtained for each resistor shall conform to the curve specified (see 3.1) and fall within the tolerance limits specified in table III (for the appropriate tolerance characteristic) at each of the temperature points indicated in table III.



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3.16 Thermal shock. When resistors are tested as specified in 4.6.14, resistors shall show no evidence of mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1).

3.17 Resistance to soldering heat (if applicable) (see 3.1). When resistors are tested as specified in 4.6.15, resistors shall show no evidence of mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1).

3.18 Moisture resistance. When resistors are tested as specified in 4.6.16, resistors shall show no signs of electrical damage, breaking, cracking, or loosening of the terminals. The change in zero-power resistance shall not exceed the value specified (see 3.1). In addition, the insulation resistance shall not be less than 100 megohms minimum (see 4.6.6).

3.19 Load life. When resistors are tested as specified in 4.6.17, resistors shall show no evidence of corrosion or other mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1).

3.20 High temperature exposure. When resistors are tested as specified in 4.6.18, the change in zero-power resistance after 100 hours, and after 1000 hours shall not exceed the value specified (see 3.1).

3.21 Vibration, high frequency. When resistors are tested as specified in 4.6.19, there shall be no evidence of mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1).

3.22 Shock, specified pulse. When resistors are tested as specified in 4.6.20, resistors shall show no evidence of mechanical damage and the change in zero-power resistance shall not exceed the value specified (see 3.1).

3.23 Immersion. When resistors are tested as specified in 4.6.21, there shall be no evidence of mechanical damage. The change in zero-power resistance shall not exceed the value specified (see 3.1). In addition, the insulation resistance shall be 100 megohms, minimum (see 4.6.6).

3.24 Resistance to solvents. When resistors are tested as specified in 4.6.22, there shall be no evidence of mechanical damage and the marking shall remain legible.

3.25 Marking. Resistors shall be marked with the PIN and the manufacturer's name, trademark, or code symbol, in accordance with MIL-STD-1285. If lack of space requires it, packages only may be marked. Example of marking:

RTH06AS102G

3.26 Workmanship. Resistors shall be processed in such a manner as to be free from cracks, holes, or chips, and other defects that will affect life, serviceability, or appearance.

## 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 or tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his 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 this specification where such inspections are deemed necessary to ensure 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.



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4.1.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ANSI/NCSL Z540-1-1994.

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

a. Qualification inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

4.3 Inspection conditions and precautions.

4.3.1 Conditions. Unless otherwise specified herein, all inspections shall be in accordance with the GENERAL REQUIREMENTS OF MIL-STD-202.

4.3.2 Precautions. Adequate precautions shall be taken during inspection to prevent condensation of moisture on the resistors, except on the moisture-resistance test.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2) on sample units produced with equipment and procedures normally used in production.

4.4.1 Sample. The number of sample units comprising a sample of resistors to be submitted for qualification inspection shall be as specified in the appendix to this specification. The sample shall be taken from a production run, and shall be produced with equipment and procedures normally used in production.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in table V, in the order shown. All sample units with the exception of those for group II shall be subjected to the inspection of group I. The 50 sample units from group I shall than be divided as specified in table V for groups III to VII inclusive, and subjected to the inspection for their particular group.

4.4.3 Failures. Failures in excess of those allowed in table V shall be cause for refusal to grant qualification.

4.4.4 Retention of qualification. To retain qualification, the contractor shall forward a report at 6 month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

a. A summary of the results of the tests performed for inspection of product for delivery (group A and group B), indicating, as a minimum, the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.

b. A summary of the results of tests performed for periodic inspection (group C), including the number and mode of failures. The summary shall include results of all periodic inspection tests performed and completed during the 6 month period. If the summary of the test results indicate nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the QPL.

Failure to submit the report within 30 days after the end of each 6 month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 6 month period that inspection data indicates failure of the qualified product to meet the requirements of this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit his qualified products to testing in accordance with the qualification inspection requirements and the reason for no production.



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4.5 Quality conformance inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A and group B tests; however, group B tests shall not delay delivery.

4.5.1.1 Inspection lot. An inspection lot shall consist of all resistors of the same style, resistance ratio, characteristic, lead type, and protective enclosure or coating under essentially the same conditions and offered for inspection during a period of 1 month.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table VI, and shall be made on the set of sample units, in the order shown. Resistors subjected to subgroup II shall not be supplied against purchase order.

4.5.1.2.1 Subgroup 1. A sample of parts from each inspection lot shall be randomly selected in accordance with table VII. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table VII. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.1.2.2 Subgroup 2 (solderability).

4.5.1.2.2.1 Subgroup 2. A sample of parts from each inspection lot shall be selected randomly in accordance with table VII and subjected to the subgroup 2 solderability test. The manufacturer may use electrical rejects from subgroup 1 screening tests for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed.

* 4.5.1.2.2.2 Rejected lots. In the event of one or more defects, the inspection lot is rejected. The manufacturer may use one of the following options to rework the lot:

a. Each production lot that was used to form the failed inspection lot shall be individually submitted to the solderability test as required in 4.6.4. Production lots that pass the solderability test are available for shipment. Production lots failing the solderability test can be reworked only if submitted to the solder dip procedure in 4.5.1.2.2.2b.

* b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.3.1.3. Following the solder dip, the electrical measurements required in group A, subgroup 1 tests shall be repeated on 100 percent of the lot. Lot acceptance criteria shall be as for subgroup 1. Additional samples shall be selected in accordance with table VII and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot may be reworked a second time and retested. If the lot fails the second rework, the lot shall be considered rejected and shall not be furnished against the requirements of the specification.



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TABLE V. Qualification inspection.

| Inspection | Requirement paragraph | Method paragraph | Number of sample units | Allowable defects 1/ | |
|---|---|---|---|---|---|
| Group I | | | | | |
| Visual and mechanical inspection 2/ 3/ | 3.3, 3.25, 3.26 | 4.6.1 | All sample units 4/ | 0 | |
| Zero-power resistance 3/ | 3.4 | 4.6.2 | | | |
| Resistance ratio characteristic 3/ | 3.5 | 4.6.3 | | | |
| Group II | | | | | |
| Solderability (if applicable) | 3.6 | 4.6.4 | 12 both leads | 1 | |
| Resistance to solvents | 3.24 | 4.6.22 | 12 | 1 | |
| Group III | | | | | 2 |
| Short time overload | 3.7 | 4.6.5 | 10 | 1 | |
| Insulation resistance | 3.8 | 4.6.6 | | | |
| Dielectric withstanding voltage (if applicable) | 3.9 | 4.6.7 | | | |
| Low temperature storage | 3.10 | 4.6.8 | | | |
| High temperature storage | 3.11 | 4.6.9 | | | |
| Dissipation constant 3/ | 3.12 | 4.6.10 | | | |
| Thermal time constant 3/ | 3.13 | 4.6.11 | | | |
| Terminal strength | 3.14 | 4.6.12 | | | |
| Group IV | | | | | |
| Resistance temperature characteristic 3/ | 3.15 | 4.6.13 | 10 | 1 | |
| Thermal shock | 3.16 | 4.6.14 | | | |
| Resistance to soldering heat (if applicable) | 3.17 | 4.6.15 | | | |
| Moisture resistance | 3.18 | 4.6.16 | | | |
| Group V | | | | | |
| Load life | 3.19 | 4.6.17 | 10 | 1 | 2 |
| Group VI | | | | | |
| High temperature exposure | 3.20 | 4.6.18 | 10 | 1 | |
| Group VII | | | | | |
| Vibration, high frequency | 3.21 | 4.6.19 | 10 | 1 | |
| Shock, specified pulse | 3.22 | 4.6.20 | | | |
| Immersion | 3.23 | 4.6.21 | | | |

1/ Failure of the same resistor in one or more tests of a group shall be charged as a single defective resistor.
2/ Marking (where applicable) will be considered defective only if the marking is incorrect, incomplete, or illegible.
3/ Nondestructive tests.
4/ Sample units for group II shall not be subject to group I.



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TABLE VI. Group A inspection.

| Inspection | Requirement paragraph | Method paragraph | Sampling procedure |
|---|---|---|---|
| Subgroup I | | | |
| Visual and mechanical examination | | 4.6.1 | |
| Body dimensions | 3.3 | | |
| Diameter and length of leads | 3.3.1 | | |
| Marking (where applicable) 1/ | 3.25 | | See 4.5.1.2.1 |
| Workmanship | 3.26 | | |
| Zero-power resistance | 3.4 | 4.6.2 | |
| Resistance ratio characteristic | 3.5 | 4.6.3 | |
| Subgroup II | | | |
| Solderability (if applicable) | 3.6 | 4.6.4 | See 4.5.1.2.2 |

1/ Marking defects shall be charged only for illegible or incomplete marking. Any subsequent electrical defect shall not be charged as a marking defect.

4.5.1.2.2.3 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied on the contract.

TABLE VII. Group A sampling plan.

| Lot size | Subgroup 1 sample size | Subgroup 2 sample size |
|---|---|---|
| 1 to 90 | 100 percent | 5 |
| 91 to 3,200 | 125 | 5 |
| 3,201 to 10,000 | 192 | 8 |
| 10,001 to 35,000 | 294 | 13 |
| 35,001 to 150,000 | 294 | 20 |
| 150,001 to 500,000 | 345 | 20 |
| 500,001 and over | 435 | 20 |



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4.5.1.4 Group B inspection. Group B inspection shall consist of the tests specified in table VIII in the order shown. They shall be performed on sample units that have passed the group A tests, unless the Government considers it more practical to select a separate sample from the lot for group B inspection.

TABLE VIII. Group B inspection.

| Inspection | Requirement paragraph | Method paragraph |
|---|---|---|
| Subgroup I | | |
| Short time overload | 3.7 | 4.6.5 |
| Insulation resistance | 3.8 | 4.6.6 |
| Dielectric withstanding voltage (if applicable) | 3.9 | 4.6.7 |
| Low temperature storage | 3.10 | 4.6.8 |
| High temperature storage | 3.11 | 4.6.9 |
| Subgroup II | | |
| Resistance to solvents | 3.24 | 4.6.22 |

4.5.1.4.1 Subgroup 1. A sample of parts shall be randomly selected in accordance with table IX. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with table IX. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.5.1.4.2 Subgroup 2. Twelve samples shall be selected randomly from each inspection lot. If one or more defects are found, the lot shall be screened and defectives removed. After screening and removal of defectives, a new sample of twelve parts shall be randomly selected. If one or more defects are found in this second sample, the lot shall be rejected and shall not be supplied to this specification.

TABLE IX. Group B sampling plan.

| Lot size | Sample size |
|---|---|
| 1 to 25 | 3 |
| 26 to 50 | 5 |
| 51 to 90 | 6 |
| 91 to 150 | 7 |
| 151 to 280 | 10 |
| 281 to 500 | 11 |
| 501 to 1,200 | 15 |
| 1,201 to 3,200 | 18 |
| 3,201 to 10,000 | 22 |
| 10,001 and over | 29 |

4.5.1.4.3 Disposition of sample units. Sample units that have passed group B inspection shall not be delivered on the contract or purchase order.

4.5.1.5 Group C inspection. Group C inspection shall consist of the tests specified in table X, in the order shown. They shall be performed on sample units of each style and characteristic selected from lots that have passed group A and group B inspections. The sample units used in group B inspection are not to be used in group C inspection.

4.5.1.5.1 Sampling plan.

4.5.1.5.1.1 Monthly. For subgroup I, ten sample units of any resistance value shall be inspected monthly with one defective unit allowed. If more than one sample fails subgroup 1 tests, double the quantity of samples required shall be inspected with no defective units allowed.



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4.5.1.5.1.2 Quarterly. Thirty sample units of any zero-power resistance between the middle value and the highest value for which qualification is sought shall be inspected quarterly. Ten sample units shall be subjected to the tests of subgroup 1, and ten sample units of the value closest to the value above the middle value shall be subjected to the tests of subgroup 2. In addition, ten sample units shall be subjected to the tests of subgroup 3. One defective unit will be allowed for each subgroup, but not more than one defective for the three groups combined.

4.5.1.5.1.3 Semiannually. Ten sample units of the highest resistance value shall be inspected semiannually, with one defective unit allowed.

4.5.1.5.2 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or purchase order.

4.5.1.5.3 Noncompliance. If a sample fails to pass group C inspection, the supplier shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections, or the inspection the original sample failed, at the option of the Government). Group A and group B inspection may be reinstituted; however, final acceptance shall be withheld until group C reinspection has shown corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

TABLE X. Group C inspection.

| Inspection | Requirement paragraph | Method paragraph | Number of sample units to be tested |
|---|---|---|---|
| Monthly | | | |
| Subgroup 1 | | | |
| Dissipation constant | 3.12 | 4.6.10 | 10 |
| Thermal time constant | 3.13 | 4.6.11 | |
| Terminal strength | 3.14 | 4.6.12 | |
| Quarterly | | | |
| Subgroup 1 | | | |
| Resistance temperature characteristic | 3.15 | 4.6.13 | 10 |
| Thermal shock | 3.16 | 4.6.14 | |
| Resistance to soldering heat (if applicable) | 3.17 | 4.6.15 | |
| Moisture resistance | 3.18 | 4.6.16 | |
| Subgroup 2 | | | |
| Load life | 3.19 | 4.6.17 | 10 |
| Subgroup 3 | | | |
| High temperature exposure | 3.20 | 4.6.18 | 10 |
| Semiannually | | | |
| Vibration, high frequency | 3.21 | 4.6.19 | 10 |
| Shock, specified pulse | 3.22 | 4.6.20 | |
| Immersion | 3.23 | 4.6.21 | |

4.5.2 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-R-39032.



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4.6 Methods of inspections.

4.6.1 Visual and mechanical inspection. Resistors shall be inspected to verify that the design, construction, physical dimensions, marking, and workmanship are in accordance with this specification (see 3.1).

4.6.2 Zero-power resistance (see 3.4 and 6.7.3).

4.6.2.1 Measurements. All resistance measurements shall be made in a controlled uniform medium capable of maintaining an accuracy in temperature of:

a. ±0.01°C for beads, beads in rods, and beads in probes.

b. ±0.05°C for all other types.

4.6.2.2 Equipment sensitivity.

a. Resistance: A wheatstone bridge, or equivalent, accuracy to ±0.05 percent or better.

b. Temperature: The time response of the temperature indicator shall be compatible with that of the resistor being tested.

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

a. Mounting: Resistors shall be mounted by normal means in corrosion resistant clips mounted on .125-inch (3.17 mm) diameter brass rods.

(1) Beads: Flat noncorrosive clips shall be used. Grip the leads .250 inch ±0.0625 inch (6.35 mm ±1.587 mm) from the end of resistor body.

(2) All other types: Use suitable corrosion resistant clips. Grip the leads 1.0 inch ±0.0625 inch (25.4 mm ±1.587 mm) from the end of the resistor body.

b. Mounting plates: Use Micarta, polytetrafluoroethylene, or equivalent, insulating material.

c. Temperature stabilization: Allow enough time for medium and resistor to stabilize at required temperatures.

d. Measurements: Measure zero-power resistance at 25°C and 125°C. With the input voltage disconnected, adjust the output indicator to the zero output position. Connect input voltage source and measure zero-power resistance. Disconnect the voltage source. If the output does not return to its initial zero output position to within a tolerance equivalent to ±0.05 percent of the resistance value, the resistor shall be classified as defective.

4.6.3 Resistance ratio characteristic. (see 3.5 and 6.7.4). Compute the resistance ratio using the zero-power resistance measurement at 25°C and 125°C (see 4.6.2).

4.6.4 Solderability (where applicable) (see 3.1 and 3.6). Resistors shall be tested in accordance with method 208 of MIL-STD-202. The following details shall apply. Two terminal leads of each resistor shall be tested (see tables III and IV).



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4.6.5 Short time overload. (see 3.7).

4.6.5.1 Test procedures. The test procedure shall be as follows:

a. Obtain zero-power resistance at 25°C.

b. Mounting: See 4.6.2.3a.

c. Provide a filtered regulated dc power supply or battery.

d. Ambient: Room temperature.

e. Using the value of dissipation constant and nominal resistance value specified (see 3.1), compute the average value of $E_{th}$ and $I_{th}$ required to raise the resistor to the maximum power rating. Place the unit in a circuit accomplishing this.

f. Energize the circuit for 5 minutes.

g. De-energize the circuit for 10 minutes. Repeat this operation for ten complete cycles.

h. Examine resistor for evidence of arcing, burning, or charring.

i. Sixty minutes after removal from circuit, the zero-power resistance shall again be measured as specified in 4.6.2 (see 3.7).

4.6.6 Insulation resistance (see 3.8). Resistors shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

a. Method of mounting: As specified in 4.6.7.1.

b. Test condition letter: A.

c. Points of measurement: Between the resistor terminals connected together and the V-block.

4.6.7 Dielectric withstanding voltage (see 3.9).

4.6.7.1 Atmospheric pressure. Resistors shall be tested in accordance with method 301 of MIL-STD-202. The following details and exceptions shall apply:

a. Special preparations: Resistors shall be clamped in the trough of a 90 degree metallic V-block of such size that the body of the resistor does not extend beyond the extremities of the V-block. The resistor leads shall be so positioned that the distance between them and any point of the V-block is not less than the radius of the lead wire.

b. Nature of potential: An ac supply at commercial line frequency (not more than 100 cycles per second) and waveform.

c. Duration of application of test voltage: Maximum voltage to be applied for 2 minutes - 500 volts.

d. Rate of application of test voltage: 100 volts per second.

e. Points of application of test voltage: Between the resistor terminals (connected together) and the V-block.

f. Inspection after test: Resistors shall be inspected for evidence of mechanical damage, arcing, and breakdown.



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4.6.7.2 At reduced barometric pressure. Following the tests specified in 4.6.7.1, resistors shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

a. Method of mounting: As specified in 4.6.7.1a.

b. Test condition letter: C.

c. Magnitude of test voltage: 200 volts.

d. Nature of potential: As specified in 4.6.7.1b.

e. Points of application of test voltage: As specified in 4.6.7.1f.

f. Duration of application of test voltage: 2 minutes.

4.6.8 Low temperature storage (see 3.10).

4.6.8.1 Mounting. Mounting in accordance with 4.6.2.3a is optional. Resistors should be isolated from metal surface of cold boxes.

4.6.8.2 Procedure. Zero-power resistance shall be measured at 25°C as specified in 4.6.2. Within 1 hour after this measurement, the resistors shall be placed in a cold chamber at room temperature. The temperature shall be reduced to -62°C ±3°C, and the resistor maintained at that temperature for a period of not less than 3 hours. (For quality conformance inspection only, at the option of the supplier, the resistor may be placed in the cold chamber when the chamber is already at the extreme low temperature.) The resistors shall then be removed from the chamber and stabilized at room ambient temperature. The final zero-power resistance at 25°C shall be measured as specified in 4.6.2, not less than 1 hour from termination of the test and within a 24 hour period. The resistors shall then be examined for mechanical damaged.

4.6.9 High temperature storage (see 3.11). Measure the zero-power resistance of all test samples.

4.6.9.1 Mounting. Mounting in accordance with 4.6.2.3a is optional. Resistors should be isolated from metal surfaces of ovens.

4.6.9.2 Temperature. The temperature shall be within ±2 percent (in °C) of the maximum operating temperature specified (see 3.1).

4.6.9.3 Load condition. No load.

4.6.9.4 Duration. Test duration shall be 100 hours.

4.6.9.5 Resistance measurement. Measure and record zero-power resistance 1 hour to 24 hours later in an ambient temperature of 25°C.

4.6.10 Dissipation constant (see 3.12 and 6.7.8).

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

a. Measure zero-power resistance at 25°C and 75°C (see 4.6.2).

b. Mounting: See 4.6.2.3a.

c. Power supply: Use a dc regulated or battery power supply.

d. Place resistors in a still air controlled chamber with a minimum volume of 1,000 times the resistor body and test fixture. Chamber temperature 25°C ±1°C.

e. Loading (see figure 1): Adjust $E_{th}$ and $I_{th}$ for zero-power resistance values of 75°C. Keep load for maximum of 15 minutes.



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f. Voltage and current measurements shall be performed with a high impedance measuring circuit of an accuracy ±1 percent or better.

g. Record $I_{th}$ and $E_{th}$.

h. Compute and record the dissipation constant:

$$\frac{P}{50} = \frac{E_{th} \times I_{th}}{75°C - 25°C} \quad \text{(Milliwatts/°C)}$$

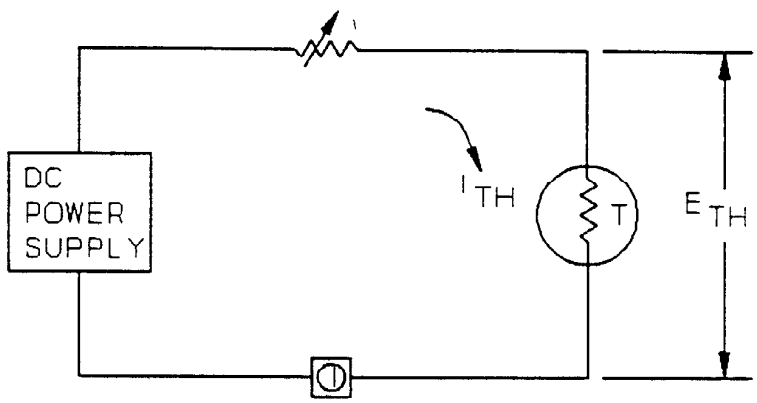


FIGURE 1. Measuring circuit.

4.6.11 Thermal time constant (see 3.13, 6.7.9, and figure 2).

4.6.11.1 Disks, rods, and beads. The test procedure shall be as follows:

a. Measure and record zero-power resistance at 43.4°C and 75°C (see 4.6.2).

b. Mounting: See 4.6.2.3a.

c. Power supply: Use a dc regulated power supply or battery.

d. Place resistors in a still air controlled chamber with a minimum volume of 1,000 times the resistor body and test fixture.

e. With switch AA closed, adjust $E_{th}/I_{th}$ ratio equal to the zero-power resistance at 75°C. Allow 15 minutes (maximum) for stabilization of resistors.

f. Set bridge (see figure 2) for null with the zero-power resistance value measured at 43.3°C in 4.6.11.1a.

g. Prepare to measure time from the instant the switch is thrown to position BB to the time the bridge indicator passes through the null point. Throw switch to BB position and record time.

h. Chamber temperature: 25°C ±1°C.



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4.6.11.2 Bends in probes and bends in rods. The test procedure shall be as follows:

a. Perform steps 4.6.11.1a, b, d, g.

b. Use test circuit (see figure 3).

c. Submerge the entire resistor in a temperature controlled (75°C ±1°C) bath of low viscosity liquid such as Dow Corning 1000, with a viscosity of one centistoke. The medium must not be subject to surface evaporation when the resistors are removed.

d. Locate a still air test chamber over liquid 75°C ±1°C bath. This chamber must have a volume of at least 1,000 times the resistor body and test fixture combined, and must be maintained at 25°C ±1°C. With a controlled drive mechanism or other means, lift the resistors from the bath into the air chamber at a uniform speed of 2 inches ±0.250 inch (50.8 mm ±6.35 mm) per second.

e. The vertical travel of the resistor shall be 4 inches ±1 inch (101.6 mm ±25.4 mm) from the surface of the liquid bath.

f. Start measuring time at the instant the resistor bead (contained in the probe or rod) leaves the surface of the bath. Note the time from this instant to the time when bridge null is reached.

g. Record this time: This is the time constant of the resistor.

NOTE: A low persistence screen oscilloscope with graduated time scale may be used in step 4.6.11.2f.

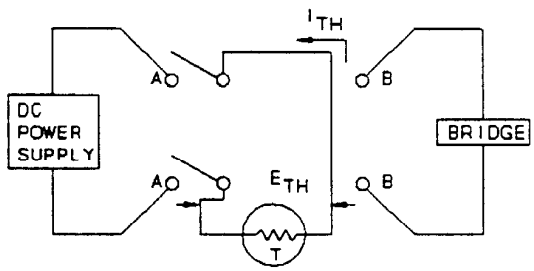


FIGURE 2. Test circuits for time constant of thermistors.

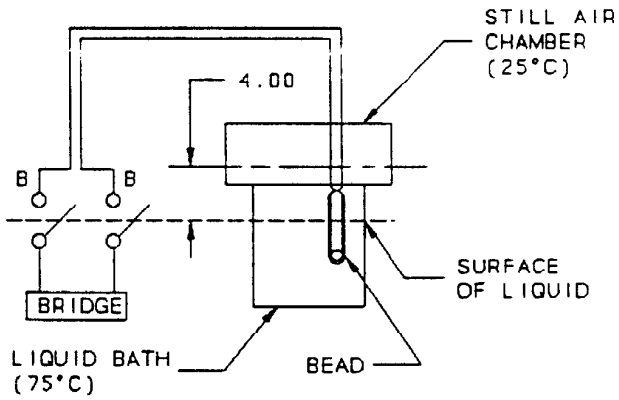


FIGURE 3. Test circuits for time constant of thermistors.



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4.6.12 Terminal strength (see 3.14).

4.6.12.1 Disk and all bead type resistors. Zero-power resistance shall be measured at 25°C as specified in 4.6.2. Resistors shall then be firmly clamped, and a pull as specified (see 3.1) shall be applied to each terminal, (one at a time) in accordance with method 211 of MIL-STD-202, test condition A. Zero-power resistance shall be again measured as specified in 4.6.2. Resistors shall then be inspected for evidence of mechanical damage.

4.6.12.2 Rod-type resistors. Zero-power resistance shall be measured a specified in 4.6.2. Resistors shall then be firmly clamped and a pull as specified (see 3.1) shall be applied to each terminal (one at a time) in accordance with method 211 of MIL-STD-202, test condition A and test condition D. Zero-power resistance shall again be measured as specified in 4.6.2; the resistor shall then be inspected for evidence of mechanical damage.

* 4.6.13 Resistance temperature characteristic (see 3.15). The resistors shall be stabilized at each of the ambient temperatures listed in table III. Zero-power resistance measurements shall be made in accordance with 4.6.2 at each specified temperature, after a stabilization time equal to or not less than ten times the applicable thermal time constant (see 3.1). Zero-power resistance shall be tabulated for each measurement.

4.6.14 Thermal shock (see 3.16). Resistors shall be tested in accordance with method 107 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: See 4.6.2.3a.

b. Measurement before cycling: Zero-power resistance shall be measured at 25°C as specified in 4.6.2.

c. Test condition letter: B - for resistors rated at 125°C; C - for resistors rated at 200°C; C - for resistors rated at 275°C.

d. Climate chamber: The rate of temperature change within the climate chamber shall not be less than 2°C per minute. The temperature shall be maintained at each of the extreme temperatures by means of circulating air. The air temperature shall be measured by a suitable method and as near the center of the group of resistors as possible.

e. When two climate chambers are used: The resistors may be transferred from one chamber to another, in which case, they shall be kept at room temperature for not less than 10 minutes and not more than 15-minutes between exposure, to the extreme temperatures.

f. Measurement after cycling: Not less than 1 hour, but within a 24 hour period after the last cycle, zero-power resistance shall be measured outside the chamber as specified in 4.6.2.

g. Inspection after the test: Resistors shall be inspected for evidence of mechanical damage.

4.6.14.1 Beads, beads in rods, and beads in probes. The resistor shall be preconditioned by being immersed in water at a temperature of 100°C +0°C, -5°C for a minimum of 15 seconds. Immediately upon conclusion of the precondition time, the resistor shall be transferred to water at a temperature of 0°C +5°C -0°C. The temperature shall remain at low temperature for minimum of 5 seconds, and then transferred to water at a temperature of 100°C +0°C, -5°C. The resistor shall remain at the high temperature for a minimum of 15 seconds. Transfer time between baths shall be less than 3 seconds. The duration of this test shall be 5 complete cycles.



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4.6.15 Resistance to soldering heat (where applicable) (see 3.1 and 3.17). Resistors shall be tested in accordance with method 210 of MIL-STD-202. The following details and exceptions shall apply:

a. Measurement before test: Zero-power resistance shall be measured as specified in 4.6.2.

b. Special preparation of specimen: Sample units shall not have been soldered during any of the previous tests.

c. Depth of immersion in the molten solder: To a point .125 inch to .1875 inch (3.17 mm to 4.7625 mm) from the resistor body.

d. Temperature of solder: 300°C ±10°C.

e. Duration of immersion: 2 seconds ±0.5 second.

f. Cooling time prior to final inspections and measurements: 24 hours ±4 hours.

g. Inspection and measurement after test: Resistors shall be inspected for evidence of mechanical damage and zero-power resistance shall be measured as specified in 4.6.2.

4.6.16 Moisture resistance (see 3.18). Resistors shall be tested in accordance with method 106 of MIL-STD-202. The following exceptions shall apply:

a. Mounting: Resistors shall be soldered by their leads to insulated stand-off terminals on a suitable panel so that there will be at least 1 inch (25.4 mm) of free air space around each resistor. The spacing of the mounts shall be such that the length of each resistor lead is .750 inch (maximum) (19.05 mm) when measured from the edge of the supporting terminal to the resistor body.

b. Initial measurements: Not less than one and one-half hours after resistors have been removed from the drying oven, the resistance shall be measured at 25°C as specified in 4.6.2.

c. Loading: During the first two hours of step 2 and step 5 of MIL-STD-202, a test potential which will maintain the resistors at their maximum power specified (see 3.1), shall be applied to 50 percent of the resistors. The remaining 50 percent of the resistors will tested without any application of voltage.

d. Final measurements: Upon completion of step 6 of MIL-STD-202 of the final cycle, the resistors shall be held at the high humidity state conditions and a temperature of 25°C ±2°C for a period of one and one-half hours to three and one-half hours. Resistors shall be removed from the chamber, and within 24 hours the insulation resistance measured (see 4.6.6). Zero-power resistance tests shall be performed as specified in 4.6.2 within 24 hours. The sample units shall not be subjected to forced circulating air during tests.

4.6.17 Load life (see 3.19). Resistors shall be tested in accordance with method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Method of mounting: Mounting shall be as specified in 4.6.2.3a and 4.6.2.3b. Resistor location shall be arranged so that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no draft on the resistors.

b. Ambient test temperature and tolerance: 25°C +5°C, -0°C.

c. Initial measurement: Zero-power resistance shall be measured at a temperature of 25°C in accordance with 4.6.2.

d. Test circuit: See figure 1.

e. Operating conditions: Apply the maximum power specified (see 3.1) intermittently, one and one-half hours on and one-half hour off for 1,000 hours.



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f. Test condition letter: D.

g. Measurements during test: The zero-power resistance shall be measured as specified in 4.6.2, at the end of each of the one-half hour off periods, after 250 hours ±12 hours, 500 hours ±12 hours, 750 hours ±12 hours, and 1,000 hours ±12 hours have elapsed.

h. Inspection after test: Resistors shall be inspected for evidence of mechanical damage.

* 4.6.18 High temperature exposure (see 3.20). Resistors shall be maintained at the applicable maximum temperature (see 3.1) for 1,000 hours +20 hours, -0 hours. Zero-power resistance will be measured at 25°C after 100 hours +10 hours, -0 hours, and at the end of the test. These measurements shall be taken after stabilization at 25°C not to exceed 72 hours.

4.6.19 Vibration, high frequency (see 3.21). Resistors shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: Resistors shall be mounted on appropriate jig fixtures with their bodies restrained from movement and their leads supported at a distance of .250 inch (6.35 mm) from the resistor body (see 6.6). These fixtures shall be constructed in a manner to insure that the points of the resistors mounting supports will have the same motion as the vibrating table. Test leads used during this test shall be no larger than AWG size 22 stranded wire, so that the influence of the test lead on the resistor will be held to a minimum. The test lead length shall be no greater than is absolutely necessary. A shielded cable, if required because of the field surrounding the vibration table, shall be clamped to the resistor mounting jig. In all cases, the resistors shall be mounted in relation to the test equipment in such a manner that the stress applied is in the direction that is considered most detrimental.

b. Initial measurement: Zero-power resistance shall be measured at 25°C as specified in 4.6.2.

c. Test condition letter: D.

d. Direction of motion: In each of two mutually perpendicular directions, one perpendicular and the other parallel to the longitudinal axis of the resistor.

e. Measurement during test: Each resistor shall be monitored to determined electrical discontinuity by a method which shall be sensitive enough to monitor or register (automatically) any electrical discontinuity of 0.1 millisecond or greater duration.

f. Measurement after vibration: Zero-power resistance shall be measured at 25°C as specified in 4.6.2.

g. Inspection after test: Resistors shall be inspected for evidence of mechanical and electrical damage.

4.6.20 Shock, specified pulse (see 3.22). Resistors shall be tested in accordance with method 213 of MIL-STD-202. The following details and exceptions shall apply:

a. Special mounting means: Resistor shall be mounted on appropriate jig fixtures with their bodies restrained from movement and their leads supported at a distance of .250 inch (6.35 mm) from the resistor body (see 6.6). These fixtures shall be constructed in a manner to insure that the points of the resistor mounting supports will have the same motion as the shock table. Resistors shall be mounted in relation to the test equipment in such a manner that the stress applied is in the direction which would be considered most detrimental. Test leads used during this test shall be no larger than AWG size 22 stranded wire, so that the influence of the test lead on the resistor will be held to a minimum. The test lead length shall be no longer than necessary.

b. Test condition letter: A.

c. Measurements before shock: Zero-power resistance shall be measured at 25°C as specified in 4.6.2.



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d. Number and direction of applied shocks: The resistors shall be subjected to a total of ten shocks in each of two mutually perpendicular planes (one perpendicular and the other parallel to longitudinal axis of the resistor).

e. Measurement during shock: Each resistor shall be monitored to determine electrical discontinuity by a method which shall at least be sensitive enough to monitor or register automatically any electrical discontinuity of 0.1 millisecond or greater duration.

f. Measurement after shock: Zero-power resistance shall be measured at 25°C as specified in 4.6.2.

g. Inspection after test: Resistors shall be inspected for evidence of mechanical and electrical damage.

4.6.21 Immersion (see 3.23). Resistors shall be tested in accordance with method 104 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter: B.

b. Inspection after last cycle: There shall be no evidence of mechanical damage.

c. Resistance measurement: Measure zero-power resistance not later than 24 hours after the last cycle as specified in 4.6.2. Within 2 hours, insulation resistance shall be performed in accordance with 4.6.6.

4.6.22 Resistance to solvents (see 3.24) (when applicable see 3.1). Resistors shall be tested in accordance with method 215 of MIL-STD-202. The following details shall apply:

a. Marked portion of resistor shall be brushed.

b. The number of sample units shall be as specified in tables V and VIII, as applicable.

c. Resistors shall be inspected for mechanical damage and legibility of markings.

5. PACKAGING.

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-R-39032.

6. NOTES

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

6.1 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Title, number, and date of the applicable detail specification and the PIN.

* c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

* 6.2 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in the Qualified Products List (QPL) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the QPL is Navy, Bureau of Ships; and information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-ELP), 1507 Wilmington Pike, Dayton, OH 45444-5766.



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6.3 Critical voltage (applicable to NTC resistors). The current-voltage characteristic curve of NTC resistors indicates that the voltage increases with increase in current normally up to a critical voltage point. Heat produced by the current at this point causes the resistance of the resistor to decrease, thereby resulting in a voltage drop as the current increases further. A limiting series resistor (approximately .100 of nominal resistance value of resistor) is used in circuits where the maximum operating temperature might be exceeded.

6.4 Materials. There are many material grades used for construction of negative temperature coefficient resistors, for example:

a. Composed of manganese and nickel oxides.

b. Composed of manganese, nickel, and cobalt oxides.

The conductivity of each grade is characteristic of the chemical proportion of each element, and of temperature. Other semiconductor materials such as silicon, boron, etc., are used for positive temperature coefficient resistors. The intent of this specification is not to limit the types of materials used in the construction of resistors. However, the units shall comply with the performance requirements specified.

6.5 Flammability. It should be noted that this specification contains no requirements concerning the flammability of the material used in construction of the resistors. Users should take this into consideration when a particular application involves this requirement.

6.6 Mounting for shock and vibration. Where resistor bodies are restrained from movement under conditions of shock and vibration, consideration must be given to the restraining techniques effect upon the thermal characteristics of the resistor.

6.7 Definitions.

6.7.1 Thermistor. A thermistor is a thermally sensitive resistor whose primary function is to exhibit a change in electrical resistance with a change in body temperature.

6.7.2 Standard reference temperature. The standard reference temperature is the resistor body temperature at which nominal zero-power resistance is specified (25°C).

6.7.3 Zero-power resistance ($R_T$). The zero-power resistance is the dc resistance value of a resistor measured at a specified temperature with a power dissipation by the resistor low enough that any further decrease in power will result in not more than 0.1 percent (or .100 inch (2.5400 mm) of the specified measurement tolerance, whichever is smaller) change in zero-power resistance.

6.7.4 Resistance ratio characteristic. The resistance ratio characteristic identifies the ratio of the zero-power resistance of a resistor measured at 25°C to that resistance measured at 125°C (see 4.6.3).

6.7.5 Zero-power temperature coefficient of resistance (alpha $a_T$). The zero-power temperature coefficient of resistance is the ratio at a specified temperature (T), of the rate of change of zero-power resistance with temperature to the zero-power resistance of the resistor.

$$a_T = \frac{1}{R_T} \frac{(dR_T)}{(dT)}$$

6.7.5.1 Negative temperature coefficient (NTC). A NTC resistor is one which the zero-power resistance deceases with an increase in temperature.

6.7.5.2 Positive temperature coefficient (PTC). A PTC resistor is one which the zero-power resistance increases with an increase in temperature.

6.7.6 Maximum operating temperature. The maximum operating temperature is the maximum body temperature at which the resistor will operate for an extended period of time with acceptable stability of its characteristics. This temperature is the result of the internal or external heating, or both, and should not exceed the maximum value specified (see 3.1).



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6.7.7 Maximum power rating. The maximum power rating of a resistor is the maximum power which a resistor will dissipate for an extended period of time with acceptable stability of its characteristics (see 3.1).

6.7.8 Dissipation constant. The dissipation constant is the ratio, (in milliwatts per degree C) at a specified ambient temperature, of a change in power dissipation in a resistor to the resultant body temperature change.

6.7.9 Thermal time constant. The thermal time constant is the time required for a resistor to change to 63.2 percent of the total difference between its initial and final body temperature when subjected to a step function change in temperature under zero-power conditions.

6.7.10 Resistance temperature characteristic. The resistance temperature characteristics is the relationship between the zero-power resistance of a resistor and its body temperature (see 3.1).

6.7.11 Temperature-wattage characteristic. The temperature-wattage characteristic of a resistor is the relationship at a specified ambient temperature between the resistor temperature and the applied steady-state wattage.

6.7.12 Current-time characteristic. The current-time characteristic is the relationship at a specified ambient temperature between the current through a resistor and time, upon application or interruption of voltage to it.

6.7.13 Stability. The stability of a resistor is the ability of a resistor to retain specified characteristics after being subjected to designated environment or electrical test conditions.

6.8 Retinning (hot solder dip). If retinning (hot solder dip) of the leads is required see 3.3.1.3.

* 6.8.1 Tin plated finishes. Tin plating is prohibited (see 3.3.3) since it may result in tin whisker growth. Tin whisker growth could adversely affect the operation of electronic equipment systems. For additional information on this matter refer to ASTM B545.

6.9 PIN. PIN is a new term encompassing terms previously used in specifications such as part number, type designation, identification number, etc. (see 1.2.1).

6.10 Subject term (key word) listing.

a. Coefficient, negative temperature.

b. coefficient, positive temperature.

6.11 Changes from previous issue. The margins of this specification are marked with asterisks to indicate when changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.



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# APPENDIX

## PROCEDURE FOR QUALIFICATION INSPECTION

10. SCOPE

10.1 Scope. This appendix details the procedure for submission of samples, with related data, for qualification inspection of resistors covered by this specification. The procedure for extending qualification of the required sample to other resistors covered by this specification is also outlined herein. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. SUBMISSION

30.1 Sample. A sample consisting of 62 units, 31 of the lowest and highest resistance values in each resistance ratio characteristic, and 31 of the lowest (tightest) resistance tolerance in each style for which qualification is sought shall be submitted. (If solderability test is applicable and both leads are tested, use 74 sample units. However, if solderability test is applicable and one lead tested, use 86 sample units.) Units for solderability test can be of any resistance value.

30.1.1 Additional sample for extension of terminal qualification. When terminal type "S" in a style is submitted in 30.1, qualification for terminal "W" in that style and group may be granted with the added submission of 20 type "W" samples to group I, group III, and group V of table V. When terminal type "W" is submitted, qualification for type "S" may be granted with the additional submission 30 samples of type "S" to group I, group II, group III, and group V of table V.

30.2 Test data. When inspections and tests are to be performed at a Government laboratory, prior to submission, all sample units shall be subjected to all the tests indicated as nondestructive in table V. Each submission shall be accompanied by the test data obtained from these tests. The performance of the destructive tests by the supplier on a duplicate set of sample units is encouraged, although not required. All test data shall be submitted in duplicate.

30.3 Description of items. The supplier shall submit a detailed description of the resistors being submitted for inspection, including materials used for resistance element and the protective enclosure or coating.

40. EXTENT OF QUALIFICATION

40.1 Extent of qualification. The resistance range included in the qualification of any one resistor style and characteristic shall be between the resistance values which pass the qualification inspection. Qualification shall cover only the resistor types covered by the description of 30.3. Qualification of lower resistance tolerances shall qualify the higher resistance tolerances in accordance with table XI. Qualification between terminal types shall be as detailed in 30.1.1.

TABLE XI. Extension of qualification.

| Resistance tolerance | Will qualify resistance tolerance |
|---|---|
| F | F, G, J, K |
| G | G, J, K |
| J | J, K |
| K | K |



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CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 85
NASA - NA

Review activities:
Army - AR, AT, AV, ME
Navy - AS, CG, MC, OS
Air Force - 17, 19, 99

Preparing activity:
DLA - ES

(Project 5905-1411)



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**INSTRUCTIONS**

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This formimay not be used to request copies of documents, nor to request waivers, or clarification of 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.

| I RECOMMEND A CHANGE: | 1. DOCUMENT NUMBER<br>MIL-R-23648D | 2. DOCUMENT DATE (YYMMDD)<br>95/04/04 |
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3. DOCUMENT TITLE

RESISTOR, THERMAL (THERMISTOR) INSULATED, GENERAL SPECIFICATION FOR

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

| a. NAME (Last, First, Middle Initial) | b. ORGANIZATION | |
|---|---|---|
| c. ADDRESS (Include Zip Code) | d. TELEPHONE (Include Area Code)<br>(1) Commercial<br>(2) AUTOVON<br>(If applicable) | 7. DATE SUBMITTED<br>(YYMMDD) |

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