

INCH-POUND

MIL-PRF-18546G
 15 December 2004
 SUPERSEDING
 MIL-PRF-18546F
 15 May 2001

PERFORMANCE SPECIFICATION
 RESISTORS, FIXED, WIRE-WOUND
 (POWER TYPE, CHASSIS MOUNTED),
 GENERAL SPECIFICATION FOR

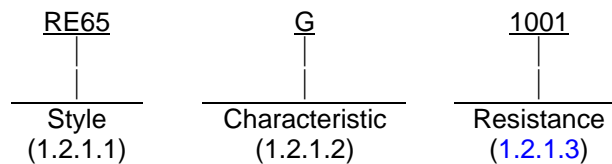
This specification is approved for use by all Departments
 and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for power type, wire wound, fixed resistors which utilize the principal of heat dissipation through a metal mounting surface. The resistors have an initial resistance tolerance of ± 1 percent and a resistance temperature characteristic range from 30 ppm/ $^{\circ}$ C to 200 ppm/ $^{\circ}$ C depending upon the resistance value. They are not suitable for application when the alternating current (ac) characteristics are of critical importance; however, provisions have been made to minimize the inductance.

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). The PIN is in the following form.



1.2.1.1 Style. The style is identified by the two letter symbol "RE" followed by a two digit number; the letters identify chassis mounted, power type, wire wound, fixed resistor, and the number identifies the size and power rating of the resistor.

1.2.1.2 Characteristic. The characteristic is identified by a single letter which identifies the maximum continuous operating temperature, and inductive (G) or noninductive (N) method of winding in accordance with [table I](#).

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAT, Post Office Box 3990, Columbus, Ohio 43218-3990 or by email resistor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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TABLE I. Characteristic.

Symbol	Method of winding	Maximum continuous operating temperature
G	Inductive	+250°C
N	Noninductive	+250°C

1.2.1.3 Resistance. The nominal resistance value expressed in ohms is identified by a four digit number; the first three represent significant figures, and the last digit specifies the number of zeros to follow. Where fractional values of an ohm, and values of less than 100 ohms are required, the letter "R" is substituted for one of the significant digits to represent the decimal point. When the letter "R" is used, the succeeding digits become significant. The following are examples of symbols for resistance values:

R050 = 0.05 ohm	1000 = 100 ohms
R100 = 0.10 ohm	1001 = 1,000 ohms
1R00 = 1.00 ohm	1002 = 10,000 ohms
10R0 = 10.0 ohms	

Minimum and maximum nominal resistance values are as specified (see 3.1). The standard resistance values for every decade will follow the sequence demonstrated for the "1 to 10" decade (see table II).

TABLE II. Standard resistance values for the 1 to 10 decade. 1/ 2/

1.00	1.27	1.62	2.05	2.61	3.32	4.22	5.23	6.49	8.00
1.02	1.30	1.65	2.10	2.67	3.40	4.32	5.36	6.65	8.06
1.05	1.33	1.69	2.15	2.74	3.48	4.42	5.49	6.81	8.25
1.07	1.37	1.74	2.21	2.80	3.57	4.53	5.62	6.98	8.45
1.10	1.40	1.78	2.26	2.87	3.65	4.64	5.76	7.00	8.66
1.13	1.43	1.82	2.32	2.94	3.74	4.75	5.90	7.15	8.87
1.15	1.47	1.87	2.37	3.01	3.83	4.87	6.00	7.32	9.09
1.18	1.50	1.91	2.43	3.09	3.92	4.99	6.04	7.50	9.31
1.21	1.54	1.96	2.49	3.16	4.02	5.00	6.19	7.68	9.53
1.24	1.58	2.00	2.55	3.24	4.12	5.11	6.34	7.87	9.76
									9.90

1/ Resistors having resistance values not listed herein, or in any other decade, will be considered as not conforming to the specification.

2/ For assistance in ordering 0.0600, 0.0604, 0.0800, and 0.0806, the procuring activity shall contact the QPL manufacturer.

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 or recommended for additional information or as examples. While every effort has been made to ensure the completeness of the 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 document to the extent specified herein. Unless otherwise specified, the issue of these documents are those cited in the solicitation or contract (see 6.2).

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DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-R-18546/1](#) - Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Styles RE60, RE65, RE70, and RE75.
- [MIL-PRF-18546/2](#) - Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Styles RE77 and RE80.
- [MIL-PRF-39009](#) - Resistors, Fixed, Wire-Wound (Power Type, Chassis Mounted), Nonestablished Reliability, and Established Reliability, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-202](#) - Test Methods Standard Electronics and Electrical Component Parts.
- [MIL-STD-1285](#) - Marking of Electrical and Electronic Parts.

DEPARTMENT OF DEFENSE HANDBOOKS

- [FED-STD-H28](#) - Screw Thread Standards for Federal Services.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Order Desk, 700 Robbins Avenue, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents cited on the solicitation or contract (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- [ANSI/NCSL Z540-1](#) - Laboratories, Calibration, and Measuring and Test Equipment.

INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)

- [ISO 10012-1](#) - Equipment, Quality Assurance Requirements for Measuring - Part 1: Meteorological Confirmation System for Measuring Equipment.

(Application for copies is available online at <http://www.ansi.org/> or should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

(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.)

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

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3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern (see 6.2).

3.2 Qualification. Resistors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable [Qualified Product List \(QPL\)](#) at the time of award of contact (see 4.4 and 6.3).

3.3 Material. The material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the resistors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.4 Interface and physical dimension. Resistors shall meet the interface and physical dimensions specified (see 3.1). Resistors shall be wound with a resistance wire (round or flat-wound ribbon), except as required for noninductive performance of applicable styles (see 3.1). When applicable, in order to minimize inductance, resistors shall be wound by one of the following methods:

- a. Ayrton-Perry.
- b. Bifilar.
- c. Or equivalent method.

3.4.1 Protective coating or enclosure. The resistance element and caps shall be protected by a coating or an enclosure which shall completely cover the exterior of the resistance element and caps. The enclosure shall be free from holes, fissures, chips, and other faults. Small cracks and molding flaws which do not adversely affect the unit's ability to meet all environmental requirements of this specification will not be considered a cause for rejection. The exposed end of the enclosure shall prevent the entrapment of moisture.

3.4.2 Housing. The housing shall be protected against corrosion. All fasteners shall be plated. Unplated copper bearing metals shall not be used in contact with aluminum.

3.4.3 Terminals. When applicable, terminals shall be treated to facilitate soldering. When a coating containing tin is used, the tin content shall range between 40 percent and 70 percent. The terminals shall be firmly secured and shall not be solely dependent on the protective coating or enclosure for mechanical anchorage.

3.4.3.1 Solder dip (retinning) leads. Only the manufacturer or his authorized [MIL-PRF-39009](#) category B or C distributor may solder dip/retin the leads of product supplied to this specification provided the solder dip/retin process (see [appendix A](#)) has been approved by the qualifying activity.

3.4.4 Threaded parts. All threaded parts shall be in accordance with [FED-STD-H28](#).

3.4.5 Weight. Resistors shall not exceed the maximum weight specified (see 3.1).

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3.5 Voltage rating. Resistors shall have a rated direct current (dc) continuous working voltage, or an approximate sine wave root mean square (rms) continuous working voltage at commercial line frequency and waveform corresponding to the power rating, as determined from the following formula:

$$E = \sqrt{PR}$$

Where: E = rated dc or rms continuous working voltage.

P = power rating (see 3.1).

R = nominal resistance.

3.6 DC resistance. When resistors are tested as specified in 4.7.2, the dc resistance shall be within 1 percent of the nominal resistance (see 1.2.1.3 and 3.1).

3.7 Solderability (as applicable) (see 3.1). When resistors are tested as specified in 4.7.3, the flat portion of the terminal shall be considered as the solderable area, and must be completely solderable.

3.8 Terminal strength. When resistors are tested as specified in 4.7.4, there shall be no evidence of mechanical damage. The change in resistance shall not exceed $\pm(0.2$ percent +0.05 ohm).

3.9 Resistance temperature characteristic. When resistors are tested as specified in 4.7.5, the resistance temperature characteristic shall not exceed 30 ppm/ $^{\circ}$ C for resistance values of 20 ohms and higher, 50 ppm/ $^{\circ}$ C for resistance values from 1 ohm to 19.6 ohms, ± 100 ppm/ $^{\circ}$ C for resistance values from 0.1 ohm to 0.976 ohm, and ± 200 ppm/ $^{\circ}$ C for resistance values from 0.05 ohm to 0.09 ohm.

3.10 Dielectric withstanding voltage. When resistors are tested as specified in 4.7.6, resistors shall not flashover, show any evidence of damage, arcing, or insulation breakdown, nor a change in resistance in excess of $\pm(0.2$ percent +0.05 ohm) as applicable.

3.11 Insulation resistance. When resistors are tested as specified 4.7.7, the insulation resistance shall not be less than 10,000 megohms.

3.12 Low temperature operation. When resistors are tested as specified in 4.7.8, the change in resistance shall not exceed $\pm(0.5$ percent +0.05 ohm) and there shall be no any evidence of mechanical damage which will result in degradation of performance.

3.13 Short time overload. When resistors are tested as specified in 4.7.9, the change in resistance shall not exceed $\pm(0.5$ percent +0.05 ohm), and there shall be no evidence of arcing, burning, or charring.

3.14 Moisture resistance. When resistors are tested as specified in 4.7.10, the change in resistance shall not exceed $\pm(1$ percent +0.05 ohm). The insulation resistance shall not be less than 1,000 megohms. There shall be no evidence of breaking, cracking, loosening of terminals, or corrosion.

3.15 Life. When resistors are tested as specified in 4.7.11, the resistors shall dissipate not less than the rated power input (see 3.1) without exceeding a change in resistance in excess of $\pm(1$ percent +0.05 ohm) between the initial measurement and any succeeding measurement. The insulation resistance shall be not less than 10,000 megohms, and there shall be no evidence of mechanical damage.

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3.16 Shock, (specified pulse). When resistors are tested as specified in 4.7.12, there shall be no electrical discontinuity during the test, the change in resistance shall not exceed $\pm(0.2$ percent $+0.05$ ohm), and there shall be no evidence of mechanical damage. Resistors shall meet the dielectric withstanding voltage requirements specified in 3.10.

3.17 Vibration, high frequency. When resistors are tested as specified in 4.7.13, there shall be no electrical discontinuity during the test, the change in resistance shall not exceed $\pm(0.2$ percent $+0.05$ ohm), and there shall be no evidence of mechanical damage. Resistors shall meet the dielectric withstanding voltage requirements specified in 3.10.

3.18 Marking. Resistors shall be marked with the type designation and the manufacturer's name, trademark, or code symbol and shall be in accordance with MIL-STD-1285. All marking may appear on one flat side at the manufacturer's option; however, all marking must be visible after mounting. There shall be no space between the symbols which comprise the type designation. Marking shall remain legible at the end of all tests.

3.18.1 Beryllium oxide (BeO). Manufacturers which use beryllium oxide in their construction shall mark each resistor body and resistor package with the symbol "BeO".

3.19 Soldering. Where soldering is employed, only noncorrosive fluxes shall be used unless it can be shown that corrosive elements have been satisfactorily removed after soldering. Solder shall not be used for obtaining mechanical strength. Electrical connections shall be mechanically secure before soldering and electrically continuous after soldering. Except for solder used to coat the terminals, the solder used shall in no case start to melt at a temperature less than $+300^{\circ}\text{C}$.

3.20 Recycling, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.21 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall be free from holes, fissures, chip, corrosion, and malformation; the terminals shall be unbroken and not crushed or nicked; and the resistors shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified here are classified as follows:

- a. Qualification inspection (see 4.4).
- b. Conformance inspection (see 4.6).

4.2 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with ANSI/NCSL Z540-1, ISO 10012-1, or equivalent system as approved by the qualifying activity.

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4.3 Inspection conditions and precautions.

4.3.1 Conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the [GENERAL REQUIREMENT](#) of [MIL-STD-202](#).

4.3.2 Precautions. Adequate precautions shall be taken during tests to prevent condensation or moisture on resistors, except during the moisture resistance tests.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see [6.3](#)) 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 III](#), in the order shown. All sample units except those listed under group IA shall be subjected to the inspection of group I. The 18 sample units shall then be divided equally into 3 groups of 6 sample units each, for groups II to IV inclusive, and subjected to the inspection for their particular group. The uncoated or enclosed sample units shall be subjected to the inspection of group V.

4.4.3 Failures. Failures in excess of those allowed in [table III](#) shall be cause for refusal to grant qualification.

4.5 Retention of qualification. Every 12 months, the manufacturer shall verify the retention of qualification to the qualifying activity. In addition, the manufacturer shall immediately notify the qualifying activity whenever the group B inspection results indicate failure of the qualified product to meet the requirements of this specification. Verification shall be based on meeting the following requirements:

- a. The manufacturer has not modified the design of the item.
- b. The specification requirements for the item have not been amended so far as to affect the character of the item.
- c. Lot rejection for group A inspection does not exceed the group A sampling.
- d. The requirements for group B inspection are met.

When group B requirements were not met and the manufacturer has taken corrective action satisfactory to the Government, group B inspection retesting shall be instituted.

4.5.1 Alternate inspection. For the purpose of retention of qualification and conformance inspection (see [4.5](#) and [4.6](#)) the test results on identical items covered by [MIL-PRF-39009](#) may be used.

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TABLE III. Qualification inspection.

Inspection	Requirement paragraph	Method paragraph	Number of samples	Number of defectives allowed <u>1/</u>
<u>Group I</u> DC resistance <u>2/</u> Visual and mechanical inspection <u>3/</u>	3.6 3.1, 3.3 to 3.4.5 incl., 3.19 to 3.21 incl.	4.7.2 4.7.1	18 coated or enclosed sample units	0
<u>Group IA</u> <u>4/</u> Solderability <u>5/</u> Terminal strength	3.7 3.8	4.7.3 4.7.4	4 coated or enclosed sample units	1
<u>Group II</u> Resistance temperature characteristic <u>2/</u> Dielectric withstanding voltage Insulation resistance Low temperature operation Short time overload Moisture resistance	3.9 3.10 3.11 3.12 3.13 3.14	4.7.5 4.7.6 4.7.7 4.7.8 4.7.9 4.7.10	6 coated or enclosed sample units	
<u>Group III</u> Life	3.15	4.7.11	6 coated or enclosed sample units	
<u>Group IV</u> Shock, (Specified pulse) Vibration, high frequency	3.16 3.17	4.7.12 4.7.13	6 coated or enclosed sample units	
<u>Group V</u> Visual and mechanical inspections	3.1, 3.3 to 3.4.5 incl., 3.19 to 3.21 incl.	4.7	4 coated or enclosed sample units	

1/ Failure of a resistor in one or more tests of a group shall be charged as a single defect.

2/ Nondestructive tests.

3/ Marking shall be considered defective only if marking or any portion thereof is illegible. Marking shall remain legible at the end of all tests.

4/ These sample units are subjected to group IA only.

5/ As applicable (see 3.1).

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A and group B inspections.

4.6.1.1 Inspection lot. An inspection lot, as far as practical, shall include resistors of any style within a given group shown in [table IV](#) without regard to resistance value or resistance tolerance, produced under essentially uniform conditions and offered for inspection at one time. Resistors which differ in design, construction, materials, and terminal type shall not be included in one lot.

4.6.1.2 Production lot. A production lot consists of parts manufactured from the same basis raw materials, processed under the same specifications and procedures, and produced with the same equipment. Each production lot of parts should be a group identified by a common manufacturing record through all significant manufacturing operations.

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4.6.2 Group A inspection. Group A inspection shall consist of the inspection specified in table IV, and shall be made on the same set of sample units, in the order shown.

TABLE IV. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	Number of samples
<u>Subgroup 1</u> DC resistance	3.6	4.7.2	See 4.6.2.1
<u>Subgroup 2</u> Visual and mechanical inspections Material Dimensions Design and construction (other than dimensions) Marking Soldering Workmanship	3.3 3.4 3.4.1 to 3.4.3 inclusive 3.18 3.19 3.21	4.7.1	See 4.6.2.2
<u>Subgroup 3</u> Solderability <u>1/</u>	3.7	4.7.3	5

1/ The manufacturer may request the deletion of the subgroup 3 solderability test, provided an in line or process control system for assessing and assuring the solderability of leads can be validated and approved by the qualifying activity. Deletion of the test does not relieve the manufacturer from meeting this test requirement in case of dispute. If the design, material, construction, or processing of the part is changed, or if there are any quality problems, the qualifying activity may require resumption of the test.

4.6.2.1 Subgroup 1. A sample of parts from each inspection lot shall be randomly selected in accordance with [table V](#). If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with [table V](#). If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification. Resistance values in the samples shall be representative, and where possible, in proportion to the resistors in the inspection lot.

4.6.2.2 Subgroup 2. A sample of parts from each inspection lot shall be randomly selected in accordance with [table V](#). If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of parts shall be randomly selected in accordance with [table V](#). If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.2.3 Subgroup 3 (solderability).

4.6.2.3.1 Sampling plan. Five samples shall be selected randomly from each inspection lot and subjected to the subgroup 3 solderability test. If there are one or more defects, the lot shall be considered to have failed.

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TABLE V. Group A sampling plan.

Lot size	Subgroup 1 sample size	Subgroup 2 Sample size
2 to 13	100 percent	100 percent
14 to 125	100 percent	13
126 to 150	125	13
151 to 280	125	20
281 to 500	125	29
501 to 1,200	125	34
1,201 to 3,200	125	42
3,201 to 10,000	192	50
10,001 to 35,000	294	60
35,001 to 150,000	294	74
150,001 to 500,000	345	90
500,001 and over	435	102

4.6.2.3.2 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 individually submitted to the solderability test as required in 4.7.3. 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 4.6.2.3.2b.
- b. The manufacturer submits the failed lot to a 100 percent solder dip using an approved solder dip process in accordance with 3.4.3.1. Following the solder dip, the electrical measurements required in group A, subgroup 2 tests shall be repeated on 100 percent of the lot. The Percent Defective Allowable (PDA) for the electrical measurements shall be as for the subgroup 1 tests. Five additional samples shall then be selected and subjected to the solderability test with zero defects allowed. If the lot fails this solderability test, the lot shall 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 this specification.

4.6.2.3.2.1 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.

4.6.3 Group B inspection. Group B inspection shall consist of the test specified in table VI, in the order shown. They shall be performed on sample units that have been subjected to and have passed the group A inspection, unless the Government considers it more practical to select from the lot for group B inspection.

4.6.3.1 Sampling plan. A sample of 13 parts (highest value) shall be randomly selected. If one or more defects are found, the lot shall be rescreened and defects removed. After screening and removal of defects, a new sample of 13 parts shall be selected. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.6.3.2 Deposition of sample units. Sample units which have been subjected to group B inspections may be delivered on the acquisition document provided they are within resistance tolerance.

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TABLE VI. Group B inspection. 1/

Inspection	Requirement paragraph	Method paragraph	Number of sample	Number of defects allowed
Resistance temperature characteristic	3.9	4.7.5	13 (highest value)	0

1/ If the manufacturer can demonstrate that this test has been performed five consecutive time with zero failures, the frequency of this test, with the approval of the qualifying activity, can be performed on an annual basis. If the design, material, construction or processing of the part is changed, or if there are any quality problems or failures, the qualifying activity may require resumption of the original test frequency.

4.6.4 Inspection of packaging. The sample and inspection of the packaging, preservation, and container marking shall be in accordance with the requirements of [section 5](#).

4.7 Methods of inspections.

4.7.1 Visual and mechanical inspections. Resistors shall be inspected to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see [3.1](#), [3.3 to 3.4.5](#) inclusive, and [3.19 to 3.21](#) inclusive).

4.7.2 DC resistance (see [3.6](#)). Resistors shall be tested in accordance with [method 303](#) of [MIL-STD-202](#). The following details and exceptions shall apply:

- a. The same measuring apparatus shall be used for any one test, but not necessarily for all tests.
- b. Test voltage: The test voltage shall not exceed 1 percent of rated dc voltage (see [3.1](#)). The voltage used for initial measurement shall for all subsequent measurements.

4.7.3 Solderability (see [3.7](#)). Resistors shall be tested in accordance with [method 208](#) of [MIL-STD-202](#). The following details shall apply:

- a. Both terminals of each sample shall be tested.
- b. Terminals shall be immersed sufficiently to cover the flat portion.

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4.7.4 Terminal strength (see 3.1 and 3.8). Resistors shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Test condition letters A and E (pull test and torque test, respectively): Test condition A for all terminal types, and test condition E for screw thread terminals.
- b. Method of holding:
 - (1) Test condition A: The resistor body shall be firmly mounted and the specified direct pull (see 3.1) applied to the hole or nut of each terminal, as applicable, for at least 30 seconds, one terminal at a time.
 - (2) Test condition E: The resistor body shall be firmly mounted and specified torque (see 3.1) shall be applied to each terminal, one at a time.
- c. Measurement before and after test: DC resistance shall be measured as specified in 4.7.2.
- d. Inspection after test: Resistors shall be inspected for evidence of mechanical damage.

4.7.5 Resistance temperature characteristic (see 3.9). Resistors shall be tested in accordance with method 304 of MIL-STD-202. The following detail shall apply:

Test temperature shall be in accordance with table VII.

TABLE VII. Resistance temperature characteristic test temperature.

Sequence	Temperature °C ±3°C	
	Qualification inspection	Conformance inspection <u>2/</u>
1	+25 <u>1/</u>	+25 <u>1/</u>
2	-55	-55
3	+25 <u>1/</u>	+25 <u>1/</u>
4	+125	
5	+200	
6	+250	+250

1/ This temperature shall be considered the reference temperature for each of succeeding temperatures.

2/ At the option of the manufacturer, the reverse sequence may be as follows:

- 1: +25°C ±3°C 1/
- 2: +250°C ±3°C
- 3: +25°C ±3°C 1/
- 4: -55°C ±3°C

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4.7.6 Dielectric withstanding voltage (see [3.10](#)).

4.7.6.1 Atmospheric pressure. Resistors shall be tested in accordance with [method 301](#) of [MIL-STD-202](#). The following details shall apply:

- a. Special preparations: Resistors shall be mounted firmly on a metal plate by means of the normal mounting hardware. The plate shall be of sufficient size to extend beyond the resistor extremities.
- b. Magnitude of test voltage: As specified in [3.1](#).
- c. Nature of potential: An ac supply at commercial line frequency and waveform.
- d. Points of application of test voltage: Between the terminals tied together and mounting plate, making certain that there is good electrical contact between the metal of the mounting tab, if any, and mounting plate.
- e. Measurements and inspection: Resistance (see [4.7.2](#)) shall be measured before the test. At the conclusion of the test, resistors shall be inspected for evidence of damage, arcing, flashover, and insulation breakdown.

4.7.6.2 At reduced barometric pressure. Following the test specified in 4.7.6.1, 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 4.7.6.1a.
- b. Test condition C.
- c. Magnitude of test voltage: As specified in [3.1](#).
- d. Nature of potential: As specified in 4.7.6.1c.
- e. Points of application of test voltage: As specified in 4.7.6.1d.
- f. Measurements and inspection: At the conclusion of the test, resistance shall be measured (see [4.7.2](#)). Resistors shall also be inspected for evidence of damage, arcing, flashover, and insulation breakdown.

4.7.7 Insulation resistance (see [3.11](#)). Resistors shall be tested in accordance with [method 302](#) of [MIL-STD-202](#). The following details shall apply:

- a. Test condition A.
- b. Special preparations: As specified in 4.7.6.1a.
- c. Points of measurement: As specified in 4.7.6.1d.

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4.7.8 Low temperature operation (see 3.12). Resistors shall be mounted as specified in 4.7.11.1. Following a measurement of resistance (see 4.7.2), rated voltage from an ac supply at commercial line frequency and waveform (see 3.5) shall be applied until thermal stability has been reached. The potential shall then be removed and within 8 seconds to 12 seconds, the resistors shall be subjected to an air temperature of -55°C +0°C, -5°C for a period of not less than 15 minutes or more than 30 minutes. Resistance (see 4.7.2) shall again be measured not less than 2 hours after final exposure. Resistors shall then be inspected for evidence of mechanical damage.

4.7.9 Short time overload (see 3.13). Resistors shall be mounted as specified in 4.7.11.1. One of the resistor terminals shall be grounded to the resistor housing during the test. Following a measurement of resistance (see 4.7.2), a test potential from an ac supply at commercial line frequency and waveform which will result in five times the rated wattage (see 3.1), but not to exceed the specified voltage used for the dielectric withstanding voltage test (atmospheric pressure) (see 3.1), shall be applied to the resistors for 5 seconds. Resistors (see 4.7.2) shall be measured after the resistors have stabilized at room temperature. Resistors shall then be inspected for evidence of arcing, burning, and charring.

4.7.10 Moisture resistance (see 3.14). Resistors shall be tested in accordance with [method 106 of MIL-STD-202](#). The following details and exceptions shall apply:

- a. Mounting: Resistors under load shall be mounted as specified in 4.7.11.1. Resistors under polarization shall be mounted as specified in 4.7.6.1a.
- b. Initial measurements: Resistors shall be measured as specified in 4.7.2.
- c. Load and polarization: One half of the resistors shall be subjected to load and the remaining half to polarization.
 - (1) Load: During the first 2 hours of each of steps 1 and 4, the rated dc continuous working voltage (see 3.5), derated in accordance with [figure 1](#) to the temperature attained at the end of the two hour period, shall be applied to the resistors. The negative terminals shall be electrically grounded to the mounting surface.
 - (2) Polarization: During steps 1 to 6 inclusive, a potential of 100 volts dc shall be applied with the positive side connected to the terminals tied together, and the negative side connected to the mounting plate.
- d. Final measurements and inspection: At the end of the final cycle, the resistors shall be removed from the chamber, conditioned at room ambient conditions, and the dc resistance and insulation resistance shall be measured as specified in 4.7.2 and 4.7.7, respectively, within 30 minutes ±15 minutes of removal from the chamber. The resistors shall not be wiped or forced air dried prior to these measurements. Resistors shall then be inspected for evidence of breaking, cracking, loosening of terminals and corrosion. (The subsequent 4 hours to 24 hours conditioning period and measurements do not apply).

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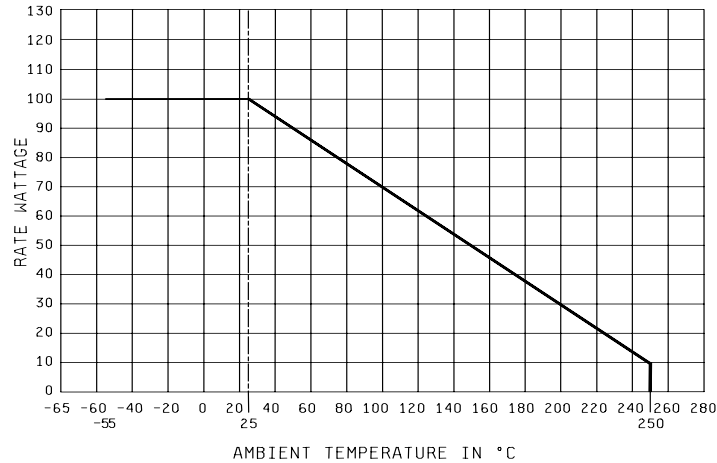


FIGURE 1. Derating curves for high ambient temperatures.

4.7.11 Life (see 3.15).

4.7.11.1 Test conditions. Life test shall be conducted at an ambient temperature of $+25^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The resistor shall be centrally mounted by normal mounting means on an aluminum chassis of the dimensions specified (see 3.1). The resistor shall be mounted with the longitudinal axis of the resistor parallel to the longitudinal axis of the chassis. The chassis shall be horizontally supported by a material having a low thermal conductivity. Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no circulation of air over the resistors other than that caused by the heat of the resistors. The voltage used shall be the rated continuous working voltage (see 3.5) from an ac supply at commercial line frequency and waveform, and adequate precaution shall be taken to maintain constant voltage on resistors under test.

4.7.11.2 Procedure. Following a measurement of resistance (see 4.7.2), the test potential shall be applied intermittently, 1 hour 30 minutes on, and 30 minutes off, for a total of 1,000 hours ± 12 hours. Resistance measurements (see 4.7.2) shall be made at the end of the 30 minutes off periods after the following hours have elapsed:

250 hours +72 hours, - 24 hours
 500 hours +72 hours, - 24 hours
 750 hours +72 hours, - 24 hours
 1,000 hours +72 hours, - 24 hours

Resistance and insulation resistance as specified in 4.7.2 and 4.7.7, respectively, shall be measured. Resistors shall then be inspected for evidence of mechanical damage. Measurement shall be made as near as possible to the specified time but may be adjusted so that measurements need not be made during other than normal weekdays.

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4.7.12 Shock (specified pulse) (see 3.16). Resistors shall be tested in accordance with [method 213](#), condition I, of [MIL-STD-202](#). The following details shall apply:

- a. Mounting: Resistors shall be mounted by their normal mounting means as specified in [4.7.11.1](#) on an appropriate mounting fixture. The mounting fixture shall be constructed in such a manner as to insure that the mounting supports remain in a static condition with reference to the shock table. Resistors shall be mounted in such a manner that the stress applied is in the direction which would be considered most detrimental.
- b. Test condition: I
- c. Measurement before shock: Resistance as specified in [4.7.2](#).
- d. 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 discontinuity having as duration of 0.1 millisecond as well as those of greater duration.
- e. Measurement inspection, and test after shock: Resistance (see [4.7.2](#)) shall be measured, and the resistors inspected for evidence of mechanical damage. Resistors shall be subjected to the dielectric withstanding voltage test (at atmospheric pressure) as specified in [4.7.6.1](#).

4.7.13 Vibration, high frequency (see 3.17). Resistors shall be tested in accordance with [method 204](#) of [MIL-STD-202](#). The following details shall apply:

- a. Mounting: Resistors shall be mounted by their normal mounting means as specified in [4.7.11.1](#) on a vibration test jig. The jig shall be so constructed so as to preclude any resonance within the test range. 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.
- b. Test condition: B.
- c. Measurements before vibration: Resistance as specified in [4.7.2](#).
- d. Measurements during vibration: 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 discontinuity having a duration of 0.1 millisecond or less, as well as those of greater duration.
- e. Measurements, inspection, and test after vibration: Resistance (see [4.7.2](#)) shall be measured, and the resistors inspected for evidence of mechanical damage. Resistors shall then be subjected to the dielectric withstanding voltage test (atmospheric pressure) as specified in [4.7.6.1](#).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see [6.2](#)). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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6. NOTES

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

6.1 Intended use. The resistors covered by this specification are military unique due to the fact that these devices must be able to operate satisfactorily in military systems under the following demanding conditions: 20 G's of high frequency vibration, 100 G's of shock (specified pulse), thermal shock (with no more than 1 percent deviation in initial resistance), and a low temperature coefficient of resistance. In addition, these military requirements are verified under a qualification system. Commercial components are not designed to withstand these military environmental conditions.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification, the applicable associated specification, and the complete PIN (see [1.2.1](#)).
- b. If not otherwise specified (see [2.1](#)), the versions of the individual documents referenced will be those in effect on the date of release of the solicitation.
- c. Packaging requirements (see [5.1](#)).

6.3 Qualification. With respect to products requiring qualification, awards are made only for products which are, at the time of award of contract, qualified for inclusion in [Qualified Products List](#) (QPL) whether or not such products have actually been so listed by the 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 awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC-VQP, Post Office Box 3990, Columbus, Ohio 43218-3990.

6.4 MIL-R-18564 substitution data. Resistors of this specification are inactive for new design, and resistors of [MIL-PRF-39009](#) of the same resistance value are used, are as follows:

<u>Inactivated specification and characteristic</u>	<u>Substitution specification</u>
MIL-R-18546/1 characteristic G	MIL-PRF-39009/1
MIL-R-18546/1 characteristic N	MIL-PRF-39009/2

6.5 Retinuing leads. If retinuing (hot solder dip) of the leads is required (see [3.4.3.1](#)).

6.6 Subject term (key word) listing.

Enclosure
Heat dissipation
Metal mounting surface
Solderable
Weldable

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6.7 Safety precautions. CAUTION: These devices use beryllium oxide ceramics in their construction. Any mechanical or chemical treatment of these ceramics which produces dust or fumes even in minute amounts can be deadly. Care should be taken to ensure that all those who handle, use, or dispose of these devices are aware of its nature and of the necessary safety precaution. In particular it should never be thrown out with general industrial or domestic waste.

6.8 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. Table VIII lists the Environmental Protection Agency (EPA) top seventeen hazardous materials targeted for major usage reduction. Unless needed to meet the requirements specified herein (see [section 3](#)), use of these materials should be minimized or eliminated.

TABLE VIII. EPA top seventeen hazardous materials.

Benzene	Dichloromethane	Tetrachloroethylene
Cadmium and Compounds	Lead and Compounds	Toluene
Carbon Tetrachloride	Mercury and Compounds	1,1,1 - Trichloroethane
Chloroform	Methyl Ethyl Ketone	Trichloroethylene
Chromium and Compounds	Methyl Isobutyl Ketone	Xylenes
Cyanide and Compounds	Nickel and Compounds	

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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APPENDIX A

PROCEDURE FOR QUALIFICATION INSPECTION

A.1 SCOPE

A.1.1 Scope. This appendix details the procedure for submission of samples 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 only.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in sections A.3, [A.4](#), and [A.5](#) of this specification. This section does not include documents cited in other sections of this specification or 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 documents cited in section A.3, [A.4](#), and [A.5](#) of this specification, whether or not they are listed.

A.2.2 Government documents.

A.2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-1276](#) - Leads for Electronic Components Parts.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094.)

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

A.3 SUBMISSION

A.3.1 Sample. A sample consisting of 18 coated or enclosed and 4 uncoated or unenclosed sample units, of the highest resistance value, and in addition, a sample consisting of 4 coated or enclosed sample units of any resistance value, shall be submitted for each style and characteristic for which qualification is sought. If the same coating or enclosure is not used, a separate sample shall be submitted for each coating and enclosure for which qualification is sought. Samples shall be representative of the supplier's normal production.

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A.4 EXTENT OF QUALIFICATION

A.4.1 Resistance values. Qualification of a particular style and resistance value will qualify a range of resistance values from the smallest value manufactured in that style to the resistance value qualified.

A.4.2 Characteristics N and G. Qualification of characteristic "N" resistors will also qualify corresponding characteristic "G" resistors. Qualification of maximum resistance value in characteristic "N" will also qualify highest value in characteristic "G".

A.5 SOLDER DIP (RETNING) LEADS

A.5.1 Solder dip (retinning) leads. The manufacturer may solder dip/retin the leads of product supplied to this specification provided the solder dip process of this appendix, or an equivalent process has been approved by the qualifying activity.

A.5.2 Qualifying activity approval. Approval of the solder dip process will be based on one of the following options:

- a. When the 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 A.5.2a, 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 dc 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 allowed.

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A.5.3 Solder dip/retraining options. The manufacturer may solder dip/retrain as follows:

- a. After the group A tests: Following the solder dip/retraining process, the electrical measurements required in group A, subgroup 1, shall be repeated on the lot note: The manufacturer may solder dip/retrain prior to the group A, subgroup 1 tests). The group A subgroup 1, lot rejection criteria shall be used. Following the test, the manufacturer shall submit the lot to the group A solderability test as specified in [4.7.3](#).
- b. As a corrective action, if the lot fails the group A solderability test: The lot may be retrained no more than two times. The lot after retraining shall be 100 percent screened for group A electrical requirements (dc resistance). Any parts failing (lot not exceeding PDA for group A, subgroup 1, (see [4.6.1.2](#)) these screens shall be supplied to this specification, if electrical failures are detected after the second retraining operation exceeding 1 percent of the lot, the lot shall not be supplied to this specification.
- c. After the group A inspection has been completed: Following the solder dip/retraining process, the electrical measurements required in group A, subgroup 1, 100 percent dc resistance shall be repeated on 100 percent of the lot. The PDA for the electrical measurements shall be as for the subgroup 1 tests (see [4.6.1.2](#)). Following these tests, the manufacturer shall submit the lot to the group A solderability test as specified in [4.7.3](#).

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Custodians:

Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:

DLA - CC

(Project 5905-2007)

Review activities:

Army - AR, MI
Navy - MC
Air Force - 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.