

PERFORMANCE SPECIFICATION

RESISTOR, FIXED, METAL STRIP, CURRENT SENSING, TERMINAL TEMPERATURE RATED,
INDUSTRIAL, HIGH RELIABILITY, SPACE LEVEL, 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 fixed, current sensing, metal strip, terminal temperature rated resistors primarily intended for incorporation into surface mount applications (see 6.6). This specification has three product levels, a space level “T” part number with 100 percent high temperature exposure and screening, a high reliability 100 percent screened “M” part number level, and an industrial grade part level “C” using the manufacturer’s inspection system to validate conformance (see 1.2.1).

1.2 Classification.

1.2.1 Part or Identifying Number (PIN). Resistors specified herein (see 3.1) are identified by a PIN which consists of the basic number of the associated specification. Each associated specification covers a different resistor style. The number is coded to provide information concerning the level of high temperature exposure screening of the resistor. The PIN is in the following form.

<u>M32783</u>	<u>01</u>	<u>B</u>	<u>R0100</u>	<u>F</u>	<u>I</u>
Specification indicating MIL-PRF- 32783	Specification sheet number indicating MIL-PRF-32783/1	Characteristic (see 1.2.3)	Resistance (see 1.2.4)	Tolerance (see 1.2.5)	Product level Designator (see 1.2.6)

1.2.2 Style. The style (see 3.1) is identified by the four-letter symbol “RC**” followed by a four-digit number. The first two letters (RC) identify a fixed, current sensing resistor, the third letter (*) identifies the number of terminals, “S” identifies two terminal resistors, and “K” identifies four terminal resistors, and the last letter (T) identifies Terminal temperature rated construction of the resistor. The last four numbers identify the size of the resistor.

1.2.3 Resistance temperature characteristic. The resistance temperature characteristic is identified by a single letter and in accordance with table I.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to 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 <https://assist.dla.mil>.



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TABLE I. Characteristic (RTC) 1/.

Symbol	Resistance temperature characteristic (RTC) in ppm/°C	Symbol	Resistance temperature characteristic (RTC) in ppm/°C	Symbol	Resistance temperature characteristic (RTC) in ppm/°C
A	±25	E	±150	J	±300
B	±50	F	±200	K	±350
C	±75	G	±250	L	±400
D	±110	H	±275	M	±750

1/ For full performance characteristics see 3.1.

1.2.4 Resistance. The nominal resistance is expressed in ohms and is identified by five characters, consisting of four digits and a letter. The letter is used simultaneously as a decimal point and as a multiplier. For resistance values:

- a. Less than 0.001 ohms, the letter "L" is used to represent a power of 10^{-3} and is always the leading character.

(i.e., L5000 = 0.0005 or L1000 = 0.0001)

- b. Greater than or equal to 0.001 but less than 0.010 ohms, the letter "L" is used to represent a power of 10^{-3} .

(i.e., 1L500 = 0.0015 or 5L000 = 0.005)

- c. Greater than or equal to 0.010 ohms but less than 1.0 ohms, the letter "R" is used to represent a decimal point and is always the leading character.

(i.e., R1500 = 0.150 or R0500 = 0.05)

- d. Values equal to 1.0 ohm or greater will use a leading non-zero digit.

(i.e., 1R500 = 1.500 or 5R000 = 5.000)

All digits preceding and following the letters "L" and "R" of the group represent significant figures. Minimum and maximum resistance values are as specified herein (see 3.1). Any values (within specification limits) may be specified, and these values can be considered as conforming to this specification.

1.2.4.1 Resistance range. The resistance range is 0.0001 to 0.2 ohms (see 3.1)

1.2.5 Resistance tolerance. Resistors are available in resistance tolerances as specified in table II.

1.2.6 Product level designator. The product level designator is identified by a single letter which denotes an industrial grade resistor (C), and military grade resistor (M), or a space level resistor (T).

1.2.7 Performance requirements. The performance requirements are defined in the individual slash sheets (see 3.1).

TABLE II. Resistance tolerance.

Symbol	Resistance tolerance percent
B	± 0.1
C	± 0.25
D	± 0.5
F	± 1.0
G	± 2.0
J	± 5.0

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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 samples. 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 sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, or handbooks. The following specifications, standards, or 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 SPECIFICATIONS

(See supplement 1 for list of associated specifications.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-202	- Electronic and Electrical Components Parts
MIL-STD-202-107	- Method 107, Thermal Shock
MIL-STD-202-108	- Method 108, Life (At Elevated Ambient Temperature)
MIL-STD-202-208	- Method 208, Solderability
MIL-STD-202-209	- Method 209, Radiographic Inspection
MIL-STD-202-210	- Method 210, Resistance to Solder Heat
MIL-STD-202-215	- Method 215, Resistance to Solvents
MIL-STD-202-218	- Method 218, Board Flex
MIL-STD-202-303	- Method 303, DC Resistance
MIL-STD-202-304	- Method 304, Resistance-Temperature Characteristic
MIL-STD-790	- Established Reliability and High Reliability Qualified Products List (QPL) Systems for Electrical, Electronic, and Fiber Optic Parts Specifications
MIL-STD-1285	- Marking of Electrical and Electronic Parts

(Copies of these documents are available online at <https://quicksearch.dla.mil/>.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications 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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA 1124	- Outgassing Data for Selecting Spacecraft Materials
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(Hard copies of this document are no longer available from the NASA Goddard Materials Branch or the Document Automation and Production Service Detachment Office (DAPS). This information is only available at <https://outgassing.nasa.gov>.)

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 are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E595	- Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
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(Application for copies are available online at <https://www.astm.org>.)

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IPC-ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

- [IPC-CC-830](#) - Qualification and Performance of Electrical Insulation Compound for Printed Wiring Assemblies
- [J-STD-002](#) - Component Leads, Termination, Lugs, Terminals and Wires, Solderability Tests for

(Application for copies are available online at <https://www.ipc.org>.)

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

3. REQUIREMENTS

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

3.2 Qualification. Resistors furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) before contract award. In addition, the manufacturer shall obtain certification from the qualifying activity that the product assurance requirements of 4.2.1 have been met and are being maintained.

3.3 QPL system. The manufacturer shall establish and maintain a QPL system for parts covered by this specification. Requirements for this system are specified in [MIL-STD-790](#) and herein.

3.4 Materials. Materials 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 guarantee of the acceptance of the finished product.

3.4.1 Terminal finish. The terminals shall be unplated, bare copper alloy unless otherwise specified (see 3.1 and 3.5.1). The use of organic solderability preservatives (OSP) for bare copper alloy terminals is acceptable.

3.5 Interface and physical dimension requirements. Resistors shall meet the interface and physical dimensions specified (see 3.1).

3.5.1 Pure tin. The use of pure tin, as an underplate or final finish is prohibited both internally and externally. Tin content of resistor components and solder shall not exceed 97 percent, by mass. Tin shall be alloyed with a minimum of 3 percent lead, by mass (see 6.4.1).

3.6 Power rating. The resistors shall have a power rating based on continuous full-load operation at a specified terminal temperature (see 3.1 and 6.6). Power shall then be derated linearly from full power at terminal temperature = 100°C to zero power at terminal temperature = 170°C (see [figure 1](#)).

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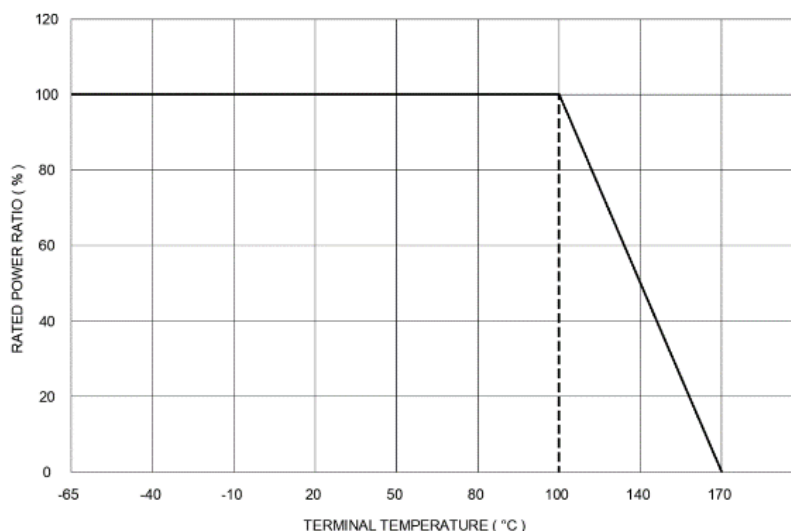


FIGURE 1. Terminal temperature power derating.

3.7 DC resistance. When resistors are tested as specified in 4.8.3, the dc resistance shall not exceed the tolerance of the nominal resistance (see 1.2.4, 1.2.5 and 3.1).

3.7.2 Mounted initial tolerance acceptance. When resistors are mounted on a PCB and the measured resistance exceeds the tolerance of the nominal resistance, the resistors will be considered acceptable if the measurements do not contain any outliers. An outlier will be defined using a statistically significant method (e.g., Grubb's Test, Modified Z-Score Test or equivalent) with a confidence level of 0.05. Lots without outliers are acceptable per 6.4.3.

3.8 Thermal shock.

3.8.1 Thermal shock (high reliability). When resistors are tested as specified in 4.8.4, there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance shall not exceed the specified value (see 3.1). For group A inspection, resistance shall also be within the nominal tolerance.

3.8.2 Thermal shock (space level). When resistors are tested as specified in 4.8.4, there shall be no evidence of mechanical damage (see 3.23.2); the combined change in resistance for thermal shock and high temperature exposure shall not exceed the specified value (see 3.1). For group A inspection, resistance shall also be within the nominal tolerance.

3.9 Burn-in (space level only). When resistors are tested as specified in 4.8.5, there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance shall not exceed the specified value (see 3.1), and the resistance shall also be within the nominal tolerance.

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3.10 Low temperature operation. When resistors are tested as specified in 4.8.6, there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance between the initial and final measurement made at 25°C ±5°C, shall not exceed specified value (see 3.1).

3.11 Short time overload. When resistors are tested as specified in 4.8.7, there shall be no evidence of arcing, burning, or charring; the change in resistance between the initial and final measurements shall not exceed the specified value (see 3.1).

3.12 High temperature exposure. When resistors are tested as specified in 4.8.8 there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance shall not exceed the specified value (see 3.1) and for Group A screening the parts shall remain in tolerance.

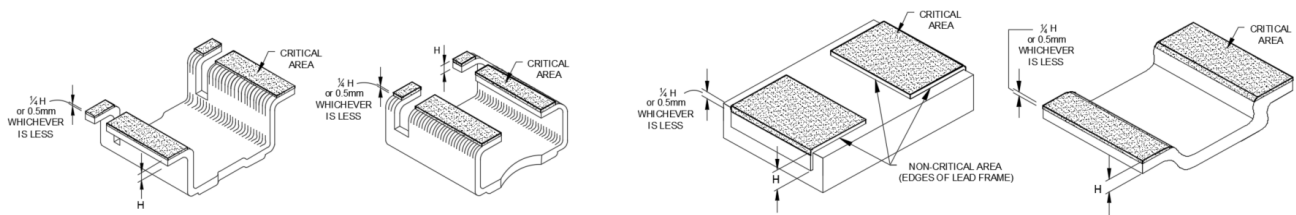
3.13 Resistance to soldering heat. When resistors are tested as specified in 4.8.9, there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance shall not exceed the specified value (see 3.1).

3.14 Resistance temperature characteristic. When resistors are tested as specified in 4.8.10, the resistance temperature characteristic, at each of the temperatures specified in 4.8.10b, shall not exceed the specified values (see 3.1).

3.15 Humidity (Steady State). When resistors are tested as specified in 4.8.11, there shall be no evidence of mechanical damage (see 3.23.2); the change in resistance shall not exceed the specified value (see 3.1).

3.16 Life. When resistors are tested as specified in 4.8.12, there shall be no evidence of mechanical damage (see 3.23.2). The change in resistance value between the initial measurement and any succeeding measurements up to and including 2,000 hours shall not exceed the specified value (see 3.1).

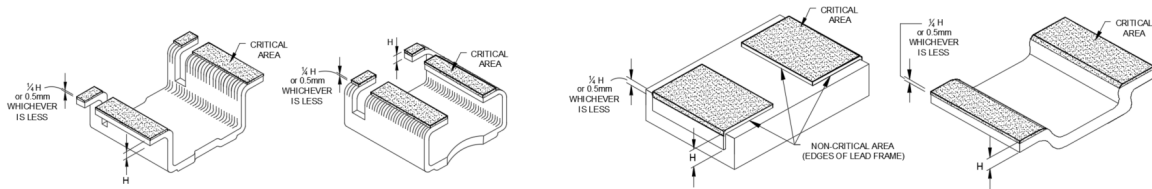
3.17 Solderability. When resistors are tested as specified in 4.8.13, the critical area as defined in figure 2 (see 3.1) shall be at least 95 percent covered with a new clean smooth coating and shall exhibit no demetallization or leaching of the terminal areas. The remaining 5 percent may contain only small pinholes or rough spots; these shall not be concentrated in one area. In case of dispute, the percentage of coverage with pinholes or rough spots shall be determined by actual measurement of these areas, as compared to the total area.



NOTE: Resistors are shown in "dead bug" configuration to highlight critical area.

FIGURE 2. Solderability coverage (Method B).

3.17.1 Solderability (alternate method). When resistors are tested as specified in 4.8.13.1, all terminals shall exhibit a continuous coating free from defects for a minimum of 95% of the critical area of any individual terminal (see figure 3 and 3.1)



NOTE: Resistors are shown in "dead bug" configuration to highlight critical area.

FIGURE 3. Solderability coverage (Method S).

3.18 Solder mounting integrity. When resistors are tested as specified in 4.8.14, there shall be no evidence of mechanical damage (see 3.23.2).

3.19 Resistance to solvents (applicable to encapsulated resistors only). When resistors are tested as specified in 4.8.15, there shall be no evidence of mechanical damage (see 3.23.2) and the marking if applicable, shall remain legible.

3.20 Board flex. When tested in accordance with 4.8.16, resistors shall meet the following:

a. Resistance:

- 1) Measured at maximum board deflection. Change in resistance between initial reading and while at maximum board deflection shall not exceed limit as specified (see 3.1).
- 2) Measured after removal of force for board flex test. Change in resistance between initial reading and post-board flex test shall not exceed limit as specified (see 3.1).

b. Visual Examination: There shall be no evidence of mechanical damage (see 3.23.2) to the resistor body or terminations when examined in accordance with 4.8.1 at the end of the test.

3.21 Marking legibility test (applicable to laser marked resistors). When resistors are tested as specified in 4.8.17, the marking shall remain legible.

3.22 Outgassing (space level only). When examined as specified in 4.8.18, the samples shall meet the following requirements:

- a. Total Mass Loss (TML) shall not exceed 1 percent.
- b. Volatile Condensable Material (VCM) shall not exceed 0.1 percent.

3.22.1 Outgassing test data (see 2.2.2). Data listed in NASA 1124 may be used in lieu of actual test data for applicable materials.

3.23 Visual and mechanical inspection. Resistors shall be inspected as specified in 4.8.1, to verify that the interface, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, and 3.5.1 inclusive, 3.27 and appendix B).

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3.23.1 Visual inspection. Visual inspection during in-process, Qualification group I, and Group A subgroup 2 inspections. When resistors are inspected as specified in 4.8.1.1.1, it shall be verified that the interface, physical dimensions, marking, and workmanship are in accordance with the applicable requirements.

3.23.2 Mechanical inspection after Group A, Group B and Group C inspections. When resistors are inspected as specified in 4.8.1.1.2, there shall be no evidence of mechanical damage as listed below.

- a. Reject for any topcoat damage exposing underlying resistor element.
- b. Reject for evidence of topcoat melting, cratering, volcaning such as may be caused by, but not limited to, resistor element hot spot.
- c. Reject for termination adhesion loss indicated by delamination of plating layers.
- d. For unencapsulated styles do not reject for discoloration of the resistor element and/or terminals related to environmental exposure during test.

3.24 Radiography. Resistors shall be inspected as specified in 4.8.2. The radiographs shall be inspected to determine if any of the defects noted below are present.

- a. Reject if metal slag crosses >50% of the kerf width (see figure 4).

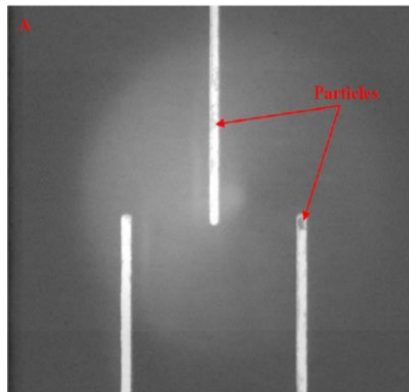


FIGURE 4. Slag crosses.

- b. Reject if kerf width is < 50% of the maximum kerf width (e.g., due to bent element or variable kerf cut geometry) (see figure 5).

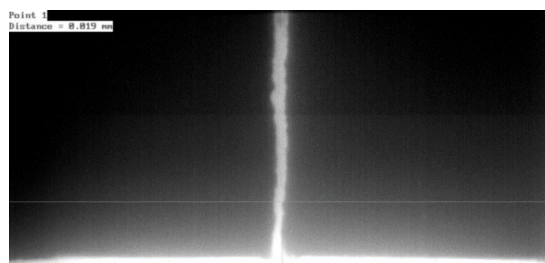


FIGURE 5. Kerf width.

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

3.26 Marking. A noncorrosive label containing the following information shall be applied to each unit package. PIN, "JAN" marking, date code, and source code. Date and source code shall be in accordance with [MIL-STD-1285](#). The following is an example of the complete marking:

12345	-	CAGE
****J	-	Date code and JAN marking
M32783 -	PIN	
010R01FT	-	Resistance value, Tolerance & Product level

The date code shall be the date of the final assembly operation. The common manufacturing record shall include the same date code as that placed on the parts covered by the record. At the option of the manufacturer, resistors may be marked (i.e., laser or screen printed). The marking process must be approved by the qualifying activity based on testing specified herein. The marking shall remain legible after all tests.

3.26.1 Individual part marking. Marking of individual resistors is not required but is permitted. Resistors may be marked using the following code system. If the resistor size and format does not allow marking, the unit package shall be labeled (see 3.26). The marking requirement shall be specified on the order.

I	0R010	J
Inspection Level	Resistance	JAN marking
(T, M, or C)		

3.26.2 JAN and J marking. The United States Government has adopted and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to and meet all the requirements of specifications. Accordingly, items acquired to, and meeting all the criteria specified herein and in applicable associated specifications shall bear the certification mark "JAN" except that item too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" or "J" shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the part number. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable associated specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets or associated specifications, the manufacturer shall remove completely the military part number and the "JAN" or "J" from the sample tested and also from all items represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration Number 6,069,576 for the certification mark "JAN" and Registration Number 2,577,735 for the certification mark "J".

3.26.3 Allowable substitution. A manufacturer may supply better products to less stringent product levels, characteristics, or resistance tolerances as specified in [table III](#). The label shall reflect the original product level, characteristics and resistance tolerance ordered. Parts that are physically marked shall not be remarked unless specified in the contract or order (see [6.2](#)).

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TABLE III. Allowable substitution.

Product level	Acceptable substitute
T (Space)	-----
M (High Reliability)	T
C (Industrial)	M, T
Characteristic	Acceptable characteristic substitute
A	--
B	A
C	A, B
D	A, B, C
E	A, B, C, D
F	A, B, C, D, E
G	A, B, C, D, E, F
H	A, B, C, D, E, F, G
J	A, B, C, D, E, F, G, H
K	A, B, C, D, E, F, G, H, J
L	A, B, C, D, E, F, G, H, J, K
M	A, B, C, D, E, F, G, H, J, K, L
Resistance tolerance	Acceptable resistance tolerance substitute
0.1	--
0.25	0.1
0.5	0.1, 0.25
1.0	0.1, 0.25, 0.5
2.0	0.1, 0.25, 0.5, 1.0
5.0	0.1, 0.25, 0.5, 1.0, 2.0

3.27 Workmanship. Resistors shall be processed in such a manner as to be uniform in quality and shall meet the requirements of 3.1, 3.4, 3.5, 3.5.1 inclusive, and 3.26 as applicable, and be free from other defects that will affect life, serviceability, or appearance, and shall pass the visual inspection as specified in [appendix B](#).

4. VERIFICATION

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

- a. Qualification inspection (see [4.4](#)).
- b. Verification of qualification (see [4.5](#)).
- c. Conformance inspection (see [4.6](#)).
- d. Periodic Group C inspection (see [4.7](#))

4.2 Reliability and quality.

4.2.1 QPL system. The manufacturer shall establish and maintain a QPL system as described in [3.3](#). Evidence of such compliance is a prerequisite for qualification and verification of qualification.

4.3 Inspections conditions and precautions.

4.3.1 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the general requirements of [MIL-STD-202](#).

4.3.2 Precautions. Adequate precautions shall be taken during inspection to prevent condensation of moisture on resistors, except during the Humidity (Steady State) tests.

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4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3).

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 [appendix A](#) to this specification. The sample shall be taken at random from a production run and shall be produced with equipment and procedures normally used in production and which have been subjected to and passed the requirements of group A inspection (see 4.6.3). Qualification shall not be granted if group A inspection requirements are not complied with.

4.4.2 Test routine. Sample units shall be subjected to the qualification inspection specified in [table IV](#) in the order shown. All sample units, with the exception of ten sample units for group V inspection, shall be subjected to the inspection of group I. The 232 sample units shall be divided as specified in [table IV](#). Group II, group III, group IV, group V, group VI, group VII, group VIII and group IX subjected to the inspection for their particular group. Sample sizes and extent of qualification shall be specified in [appendix A](#) of this specification.

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

4.5 Verification of qualification. Every 12 months the manufacturer shall provide verification of qualification to the qualifying activity. Continuation of qualification is based on meeting the following requirements.

- a. [MIL-STD-790](#) program.
- b. Design of resistor has not been modified.
- c. Lot rejection for group A (subgroup 2 and subgroup 4) does not exceed 5 percent or one lot, whichever is greater.
- d. Periodic group C inspection requirements are met.
- e. Continued qualification to the "C" level shall be based on continued maintenance of qualification for the "M" level part.

4.5.1 No Production. In the event no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and the facilities necessary to produce the item. If during 2 consecutive periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit the products (a representative of each type, grade, class, etc.) to testing in accordance with the qualification inspection requirements.

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TABLE IV. Qualification inspection.

Inspection	Requirement Paragraph	Method paragraph	Number of samples	Number of defects allowed
<u>Certification requirements</u> Outgassing (space level only)	3.22	4.8.18	---	---
<u>Group I</u> Visual and mechanical inspection	3.1, 3.4, 3.5, 3.5.1 inclusive, 3.23, and 3.27	4.8.1	All sample units except group V	0
DC resistance	3.7	4.8.3		
<u>Group II</u> Resistance to soldering heat Resistance temperature characteristic Low temperature operation Short time overload High temperature exposure	3.13 3.14 3.10 3.11 3.12	4.8.9 4.8.10 4.8.6 4.8.7 4.8.8	15 highest 15 lowest (30)	0
<u>Group III</u> Resistance to soldering heat Humidity, (Steady State)	3.13 3.15	4.8.9 4.8.11	15 highest 15 lowest (30)	0
<u>Group IV</u> Life	3.16	4.8.12	51 highest 51 lowest (102)	1
<u>Group V</u> Solderability	3.17	4.8.13	10 any value	0
<u>Group VI</u> Board flex	3.20	4.8.16	10 any value	0
<u>Group VII</u> Solder mounting integrity	3.18	4.8.14	10 any value	0
<u>Group VIII</u> Resistance to solvents ^{1/} Marking legibility test (laser marking) ^{2/}	3.19 3.21	4.8.15 4.8.17	10 any value	0
<u>Group IX</u> Thermal shock (100 cycles)	3.8	4.8.4	15 highest 15 lowest (30)	0

^{1/} Test applicable for non-laser marked parts.

^{2/} Test applicable for laser marked parts.

4.6 Conformance inspection.

4.6.1 Inspection of product for delivery.

4.6.1.1 "C" level. The manufacturer's inspection system shall be used for preparation for delivery.

4.6.1.2 "M" level. Inspection of product for delivery shall consist of group A (high temperature exposure does not apply) and group B inspections. Group B inspection for preparation of delivery is not required when the qualifying activity has allowed group B testing to be performed annually (see [table VII](#)).

4.6.1.3 "T" level. Inspection of product for delivery shall consist of group A and group B inspections and shall be performed on production lot basis. Test deletion or reduction, which may be granted for "M" level product, is not allowed for space level product.

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4.6.2 Inspection lot. An inspection lot shall consist of all resistors of the same style, characteristic, and manufactured under essentially the same process and conditions with the same basic materials during a manufacturing period of 1-month maximum. Space level lots shall be kept separate.

4.6.2.1 Production lot. A production lot shall consist of all resistors of the same style, nominal resistance value, resistance tolerance, characteristic, termination material manufactured and tested as a group using the same material, processes, specifications, and procedures. Lot identity shall be maintained throughout the manufacturing cycle .

4.6.3 Group A inspection.

4.6.3.1 "C" level part. The manufacturer shall establish and maintain an inspection system to verify that resistors meet dc resistance, visual/mechanical, and solderability requirements. In-line or process controls may be part of such a system. The inspection system shall also include criteria for lot rejection and corrective action. (NOTE: Since the "C" level resistor is the "M" level design without the mandatory conformance inspection system, this product is still expected to meet the environmental qualification type requirements (e.g., humidity, (steady state) and thermal shock).

4.6.3.2 "M" level and "T" level part. Group A inspection shall consist of the inspections specified in [table V](#).

4.6.3.2.1 Subgroup 1 test (Pre-cap visual).

- a. The subgroup 1 test shall be performed on a production lot basis. Any of the following inspections may be performed with qualifying activity approval: Pre-cap visual (unencapsulated resistors), visual after removal of encapsulation, radiography, or an approved equivalent. For M level, thirteen (13) samples shall be subjected to subgroup 1. In the event of one or more failures, the lot shall be rejected. For T level, 100% of the product shall be subjected to subgroup 1.
- b. Already encapsulated resistors:
 - (1) For M level, thirteen (13) samples shall be subjected to radiography, after which these samples shall be dismantled or cross-sectioned and visually evaluated. If the failure is detected via cross-section and/or dismantling, then the lot is rejected.
 - (2) For T level, 100% of the product shall be subjected to radiography. In addition, thirteen (13) samples shall be dismantled or cross-sectioned and visually evaluated. In case of one or more failures in the 13 piece cross section or dismantling inspection, then the lot shall be rejected.

4.6.3.2.1.1 Rejected lots.

- a. In the event of one or more defects, the production lot is rejected, and the rejected production lot(s) shall be submitted to a 100 percent inspection as specified in [3.23](#) or radiography (see [3.24](#)). Resistors that pass this inspection are available to continue group A testing.
- b. Already encapsulated resistors:
 - (1) If the failure was detected during cross section or dismantling, then the lot shall be rejected and not supplied as either M or T level.
 - (2) If the failure was detected during radiography, for M level, the rejected lot shall be submitted to 100% radiography. Resistors that pass this inspection are available to continue group A testing.

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TABLE V. Group A inspection.

Inspection	Requirement paragraph	Method paragraph	Sampling Procedure
<u>Subgroup 1</u> <u>1/</u> Pre-cap visual inspection Radiography	<u>3.23</u> <u>3.24</u>	<u>4.8.1</u> <u>4.8.2</u>	<u>4.6.3.2.1</u>
<u>Subgroup 2</u> Thermal shock <u>2/</u> High temperature exposure (space level only) DC resistance	<u>3.8</u> <u>3.12</u> <u>3.7</u>	<u>4.8.4</u> <u>4.8.8</u> <u>4.8.3</u>	<u>4.6.3.2.2</u>
<u>Subgroup 3</u> Visual inspection	<u>3.1, 3.4, 3.5, 3.5.1</u> inclusive, <u>3.23, 3.26</u> and <u>3.27</u>	<u>4.8.1</u>	<u>4.6.3.2.3</u>
<u>Subgroup 4</u> Solderability <u>3/</u>	<u>3.17</u>	<u>4.8.13</u>	<u>4.6.3.2.4</u>
<u>Subgroup 5</u> <u>4/</u> Resistance to solvents Marking legibility <u>5/</u>	<u>3.19</u> <u>3.21</u>	<u>4.8.15</u> <u>4.8.17</u>	<u>4.6.3.2.5</u>

- 1/ Subgroup 1 shall be performed when the resistance element cannot be visually inspected after encapsulation in subgroup 3. Radiography may be employed in lieu of pre-cap visual inspection.
- 2/ If the manufacturer can demonstrate that these tests have been performed five consecutive times with zero failures, the frequency of these tests, 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. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)
- 3/ The manufacturer may request the deletion of the subgroup 4 solderability test, provided an in-line or process control system for assessing and assuring the solderability of terminations 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. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)
- 4/ If the manufacturer can demonstrate that these tests have been performed five consecutive times with zero failures, the frequency of these tests, 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. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)
- 5/ Test applicable for laser marked parts.

4.6.3.2.2 Subgroup 2 tests. Subgroup 2 tests shall be performed on a production lot basis on 100 percent of the product supplied under this specification.

- a. For "M" level, resistors that are out of resistance tolerance shall be removed from the lot.
- b. After the combination of thermal shock and high temperature exposure, for "T" level resistors with tolerance of 1% or greater there shall not be more than 5% total rejects for out of tolerance or delta R.
- c. After the combination of thermal shock and high temperature exposure, for "T" level resistors with tolerance of 0.5% or less there shall not be more than 10% total rejects for either delta R or out of tolerance. The number of delta R rejects shall not exceed 5%.
- d. Lots that do not meet the percent defective allowable limits above shall not be furnished on contracts.

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4.6.3.2.2.1 Manufacturer's production inspection. If the manufacturer performs tests similar to those specified in subgroup 2, [table V](#), as the final step of the production process, group A, subgroup 2 inspection may be waived. Authority to waive the subgroup 2 inspection shall be granted by the qualifying activity only. The following criteria must be complied with:

- a. Tests conducted by the manufacturer during production shall be clearly identical to or more stringent than those specified for subgroup 2. Test conditions shall be equal to or more stringent than those specified for subgroup 2 tests.
- b. Manufacturer subjects 100 percent of the product supplied under this specification to the production tests.
- c. The parameters measured, and the failure criteria shall be the same as, or more stringent than, those specified herein.
- d. The lot rejection criteria are the same as, or more stringent than, those specified herein.
- e. Once approved, the manufacturer shall not change the test procedures or criteria without prior notification to and concurrence from the qualifying activity.

4.6.3.2.3 Subgroup 3 (visual inspection). The subgroup 3 test shall be performed on an inspection lot basis for product level M and production lot basis for space level product T. A sample of parts shall be randomly selected in accordance with [table VI](#). If one or more defects are found, the lot shall be reworked or screened, and defectives removed. After reworking or screening and removal of defectives, a new sample of parts shall be randomly selected in accordance with [table VI](#). If one or more defects are found in this second sample for the same quality characteristic, the lot shall be rejected and shall not be supplied to this specification.

4.6.3.2.4 Subgroup 4 (solderability) test. The subgroup 4 test shall be performed on an inspection lot basis for product level M and production lot basis for space level product T. A sample shall be randomly selected from each lot in accordance with [table VI](#). As an option, the manufacturer may use electrical rejects from the subgroup 2 tests for all or part of the sample. If there are one or more defects, the lot shall be considered to have failed.

4.6.3.2.4.1 Rejected lots. In the event of one or more defects, the inspection lot is rejected. If the lot fails this solderability test, the lot may be reworked and retested. Any inspection lot that fails the solderability retest shall be considered to have failed and that lot will not be supplied to the requirements of the specification.

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

TABLE VI. Sampling plans for subgroup 3 and subgroup 4.

Lot size	Sample size for subgroup 3	Sample size for subgroup 4
1 to 5	100%	100%
6 to 13	100%	5
14 to 150	13	5
151 to 280	20	5
281 to 500	29	5
501 to 1,200	34	5
1,201 to 3,200	42	5
3,201 to 10,000	50	8
10,001 to 35,000	60	13
35,001 to 150,000	74	20
150,001 to 500,000	90	20
500,001 and over	102	20

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4.6.3.2.5 Subgroup 5. The manufacturer may use electrical rejects from the subgroup 1 screening tests for all or part of the samples to be used for the subgroup 5 testing. In case there are one or more defects, the lot shall be considered to have failed.

- a. Laser marked resistors. Twelve samples of laser marked resistors shall be selected randomly from each inspection lot and subjected to the subgroup 4 tests (six to resistance to solvents and six to marking legibility).
- b. Ink marked or color dot marked resistors. Six resistors marked with color dots or screen-printed characters shall be subjected to resistance to solvents test only.

4.6.3.2.5.1 Rejected lots. In the event of one or more defects, the inspection lot is rejected. Each production lot that was used to form the failed inspection lot shall be individually submitted to the subgroup 5 test as required in 3.19 or 3.21.

- a. For either laser marked, or ink/color dot marked parts, if the failures occurred during resistance to solvents testing, then an additional eight samples shall be randomly selected from each production lot and tested for resistance to solvents.
- b. If the failures occurred during marking legibility testing, then an additional eight samples shall be randomly selected from each production lot and tested for marking legibility. If there is one or more defects in the production lot sample, that production lot shall be considered to have failed, and that product will not be supplied to the requirements of this specification. Individual production lots that pass the minimum marking test are available for shipment.

4.6.3.2.5.2 Disposition of samples. The resistance to solvents and marking legibility tests is considered a destructive tests and samples submitted to these tests shall not be supplied on the contract.

4.6.4 Group B inspection. Group B inspection shall consist of the inspections specified in table VII in the order shown and shall be performed on samples from lots which have been subjected to and have passed the group A inspection. Group B inspection shall be performed monthly on inspection lot basis for M level parts and on a production lot basis for T level parts.

4.6.4.1 Sampling plan.

4.6.4.2 Subgroup 1. Ten sample units shall be randomly selected for test. If one or more defects are found, the lot shall be rejected and shall not be supplied to this specification.

4.6.4.3 Subgroup 2. Ten sample units shall be randomly selected for test. If one or more defects are found, the lot shall be reworked or screened, and defectives removed. After reworking or screening and removal of defectives, a new sample of ten 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.

4.6.4.4 Subgroup 3. Ten sample units shall be randomly selected for test. If one or more defects are found, the lot shall be rejected and shall not be supplied to this specification.

4.6.4.5 Subgroup 4 (space level only). Ten samples shall be randomly selected for test. If one or more defects are found, the lot shall be rejected and shall not be supplied to this specification.

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

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TABLE VII. Group B inspection ("M" level and space level).

Inspection	Requirement paragraph	Method paragraph	Number of samples
<u>Subgroup 1 1/</u> Resistance temperature characteristics	3.14	4.8.10	10 samples
<u>Subgroup 2 2/</u> Solder mounting integrity	3.18	4.8.14	10 samples
<u>Subgroup 3 1/</u> Short time overload	3.11	4.8.7	10 samples
<u>Production Lot Only</u> <u>Subgroup 4</u> Burn-in (space level only)	3.9	4.8.5	10 samples

1/ If the manufacturer can demonstrate that these tests have been performed five consecutive times with zero failures, the frequency of these tests, 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. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)

2/ If the manufacturer can demonstrate that this test has been performed five consecutive times with zero failures, this test, with the approval of the qualifying activity, can be deleted. The manufacturer, however, shall perform this test every three years after the deletion as part of long-term design verification. 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 specified testing. Deletion of testing does not relieve the manufacturer from meeting the test requirement in case of dispute. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)

4.7 Periodic group C inspection. Group C inspection shall consist of the tests specified in table VIII, in the order shown. Group C inspection shall be made on sample units selected from lots which have passed group A and group B inspection. Group C samples shall be representative of production. The allowable number of defectives shall be as indicated in [table VIII](#).

4.7.1 Sampling plan. If more than 1,000 resistors of any style or style grouping are produced over the maintenance period, the group C tests shall be performed as specified. If the production rate is less than 1,000 resistors for any style or style grouping over the maintenance period, then the monthly group C inspection may be postponed until at least 1,000 resistors of that style or grouping are produced (except for the monthly life test). In any case, the monthly tests shall be performed at least once every 3 months. This requirement is waived if the manufacturer has obtained a reduced inspection status through the qualifying activity.

4.7.1.1 Monthly (subgroup 1). Ten sample units shall be accumulated from M and T level lots representative of production and shall be subjected to the test of subgroup 1. No defects shall be allowed. Each resistor style must be sampled for subgroup 1 a minimum of one time per 12 months.

4.7.1.2 Quarterly (subgroup 1). Subgroup 1 tests shall be performed on a sample size of 30 unit's representative of production with zero defective allowed for each group of 30.

4.7.1.3 Quarterly (subgroup 2). Subgroup 2 test shall be performed on a sample size of 30 units representative of production with zero defective allowed for each group of 30.

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4.7.1.4 Quarterly (subgroup 3). Subgroup 3 test shall be performed on a sample size of 30 units representative of production with zero defective allowed for each group of 30.

4.7.1.5 Annually (subgroup 1). Subgroup 1 tests shall be performed on a sample size of 10 unit's representative of production with zero defective allowed.

TABLE VIII. Group C inspection.

Inspection	Requirement paragraph	Method paragraph	Number of samples	Number of defects allowed
<u>Monthly</u>				
<u>Subgroup 1</u> Life	3.16	4.8.12	10	0
<u>Quarterly</u>				
<u>Subgroup 1</u> 1/ Resistance to soldering heat Humidity, (Steady State)	3.13 3.15	4.8.9 4.8.11	30	0
<u>Subgroup 2</u> 1/ High temperature exposure	3.12	4.8.8	30	0
<u>Subgroup 3</u> 1/ Thermal shock Low temperature operation	3.8 3.10	4.8.4 4.8.6	30	0
<u>Annually</u>				
<u>Subgroup 1</u> Board flex	3.20	4.8.16	10 any value	0

1/ If the manufacturer can demonstrate that these tests have been performed five consecutive times with zero failures, the frequency of these tests, 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. (NOTE: Not applicable to space ("T") level product since test deletion or reduction of space level product is not allowed.)

4.7.2 Noncompliance. If a sample fails to pass group C inspection, the contractor 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 and processes, 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 inspection, or the inspection which the original sample failed, at the option of the Government). Group A and group B inspections may be reinstituted; however, final acceptance shall be withheld until group C reinspection has shown that the corrective action was successful.

4.8 Methods of inspection.

4.8.1 Visual and mechanical inspection and mounting and terminal temperature measurement point.

4.8.1.1 Visual and mechanical inspection.

4.8.1.1.1 Visual inspection. Visual inspection during in-process, qualification group I, and group A subgroups 1 and 3 inspections. Unless otherwise specified, resistors shall be examined under 30X to 60X magnification. In case of conflict 30X will be the referee power, unless otherwise specified, to verify that the materials, design, construction, physical dimensions, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.5.1 inclusive, 3.27 and Appendix B).

4.8.1.1.2 Mechanical inspection. Mechanical inspection after qualification and groups A, B and C inspections. Unless otherwise specified, resistors shall be examined for mechanical damage (see 3.23.2 and Appendix B) under 30X minimum (referee power) for group A, 4X minimum (referee power) for group B and 10X minimum (referee power) for group C and qualification.

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4.8.1.2 Mounting procedures. When specified herein, the resistor shall be mounted on a test board as described in 4.8.1.3. For those test procedures where mounting requirements are unspecified, the resistors may be tested unmounted using pressure contacts.

4.8.1.3 Specified mounting. When specified in the test procedure, the resistor shall be mounted on a test board as appropriate for the specific test. The test board material shall be such that it shall not be the cause of, nor contribute to, any failure of a resistor in any of the tests for which it may be used. The test board shall be designed to ensure the resistor does not exceed the maximum temperature under rated power, e.g., 170°C. Resistors shall be mounted on the test board by soldering the terminations directly to the test board metallized land areas in the following manner:

- a. Solder and soldering flux shall be of such a quality as to enable the resistors to meet all the requirements of this specification and shall be applied to the terminations of each resistor.
- b. All resistors shall be placed across the metallized land areas of the test board with contact between the terminations and board land areas only. The use of adhesive to keep resistors in place during mounting operation is allowable except for preparation of solder mounting integrity test pieces.

4.8.1.4 Terminal temperature measurement point (see 6.6.2). The terminal temperature shall be monitored during burn-in and life test. The measurement point shall be on the terminal if practical. If not, then the temperature of the solder fillet may be used. For 4-terminal current sense resistors, the measurement point shall be one of the current terminals and/or associated solder fillet.

4.8.2 Radiography (see 3.24). The radiography shall be performed in accordance with MIL-STD-202-209 (1 view top down only). NOTE: Radiography setup parameters may need to be varied in order to detect certain features, such as metal slag in the kerfs, due to their potentially thin geometries compared to the much thicker resistor element and terminals.

4.8.3 DC resistance. The dc resistance shall be measured in accordance with MIL-STD-202-303. The following details and exceptions shall apply:

- a. Measuring apparatus: Different types of measuring test equipment (multimeters, bridges, or equivalent) are permitted to be used on the initial and final readings of this test, provided the conditions of 4.8.3b are met.
- b. Limit or error of measuring apparatus: The accuracy of measuring equipment shall be sufficient to measure the relevant resistance value with its specified tolerance. If the tolerance or resistance change limit $\leq \pm 10$ micro-ohms, (i.e., nominal resistance x tolerance) then the accuracy shall not exceed one-fourth of the resistor tolerance, or the resistance change limit for which the measurement is being made.
 - (1) Test voltage and currents: The test voltage and current shall be such that sufficient resolution is obtained (see 4.8.3b) without an excessive amount of heating effect.
 - (2) Points of measurement:
 - (a) Two terminal devices: The point-to-point measurement shall be made at a distance as specified in the associated specification (see 3.1).
 - (b) Four terminal devices: The associated specification (see 3.1) shall identify voltage and current leads. If no identification is given, then the smaller terminals shall be used for voltage sensing and this combination shall be used for any specific test (initial vs. final DC resistance readings).
- c. Temperature: The dc resistance test specified in group I of table IV shall be performed at 25°C $\pm 5^\circ\text{C}$. For all other tests, unless otherwise specified herein, the temperature at which subsequent and final resistance measurements are made in each test shall be within $\pm 2^\circ\text{C}$ of the temperature at which the initial resistance measurement was made.

NOTE: In case of dispute, four wire Kelvin measurement shall be made as close to the resistor element as possible.

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4.8.4 Thermal shock (see 3.8). Resistors shall be tested in accordance with MIL-STD-202-107. The following details and exceptions apply:

- a. Mounting: For group A inspection resistors shall not be mounted. Resistors may be placed in metal baskets, vials, or other apparatus as long as resistors are subjected to the specified temperature extremes. For qualification and group C inspection only, the resistors shall be mounted on a test board as specified in 4.8.1.3.)
- b. Measurement before cycling: DC resistance shall be measured as specified in 4.8.3.
- c. Test condition F (5 cycles) for group A and F-3 (100 cycles) for qualification and group C (except temperatures shall be 150°C +10°C, -0°C and -65°C +0°C, -10°C).
- d. Measurement after cycling: After stabilization at room temperature, the dc resistance shall again be measured as specified in 4.8.3.

4.8.5 Burn-in (space level only) (see 3.9). Resistors shall be tested in accordance with MIL-STD-202-108. The following details and exceptions shall apply:

- a. Mounting: Resistors shall be mounted on an appropriate test board(s) (see 4.8.1.3).
- b. Initial measurements: The initial dc resistance shall be measured at room temperature (see 4.8.3) after mounting of the resistors under test. This measurement shall be used as the reference temperature for all subsequent measurements under the same condition.
- c. Operating condition: One-time rated power shall be applied to the resistors intermittently, one and one-half hours "on" and one-half hour "off", for 168 hours (+16 hours/-4 hours). During the "on" cycle, the power shall be regulated and controlled to within ±5 percent.
- d. Terminal temperature: Terminal temperature shall be as specified (see 3.1) during the power on state. The combination of Printed Circuit Board (PCB) design (e.g., solder pad thickness, geometry, part to part spacing, heat sinks, etc.) and the test environment (e.g., use of baffles, covers, temperature chambers) may be adjusted in order to achieve the specified terminal temperature.
 - (1) Terminal temperature shall be monitored (see 4.8.1.4) during the power on state using 1 or more thermocouples distributed among the devices under test and/or by thermal imaging techniques.
- e. Measurements after test: Following a minimum one hour stabilization period, dc resistance shall be measured as specified in 4.8.3 under the same test conditions used for the initial measurement.

4.8.6 Low temperature operation (see 3.10). A dc resistance measurement shall be made as specified in 4.8.3, mounted on a test board as specified in 4.8.1.3. The resistors shall be placed in a cold chamber maintained at -65°C +0°C, -5°C. After stabilization at this temperature, the rated power as specified in 3.6 shall be applied for 45 minutes, +5 minutes, -0 minutes. Fifteen minutes +5 minutes, -0 minutes after the removal of the current, the resistors shall be removed from the chamber, and maintained at a temperature of 25°C ±5°C until stabilized; the dc resistance shall be measured as specified in 4.8.3.

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4.8.7 Short time overload (see 3.11). The dc resistance shall be measured as specified in 4.8.3 and mounted on a test board as specified in 4.8.1.3. A steady-state power as specified (see 3.1), and shall be applied for 5 seconds to the resistor under the following conditions:

- a. Resistors on test board shall be mounted so that the larger space of the resistor is on a horizontal plane.
- b. In still air, with no circulation other than that created by the heat of the resistors being operated.
- c. The resistors shall be stabilized at a temperature of $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ after which the dc resistance shall be measured as specified in 4.8.3.

4.8.8 High temperature exposure (see 3.12).

a. Mounting:

- (1) For qualification and group C testing the resistors shall be mounted on a test board as specified in 4.8.1.3.
- (2) For group A screening (space level only) the resistors shall be unmounted.

b. Initial measurement before test: DC resistance shall be measured as specified in 4.8.3.

c. Procedure:

- (1) For qualification and group C testing resistors shall be subjected to a continuous temperature of $170^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period of 100 hours ± 4 hours, in a test chamber with forced air circulation.
- (2) For group A testing (space level only) resistors shall be subjected to a continuous temperature of $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period of 24 hours (+24 hours, -0 hours) in a test chamber with forced air circulation.

d. Final measurement after test: The resistors shall be stabilized at $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for a minimum of 45 minutes after which the dc resistance shall be measured as specified in 4.8.3.

4.8.9 Resistance to soldering heat (see 3.13). Resistors shall be tested in accordance with MIL-STD-202-210. The following details and exceptions shall apply:

- a. Mounting and testing: Resistors shall be mounted on a test board (see 4.8.1.3) using reflow temperature per test condition J. After mounting, the DC resistance shall be measured as specified in 4.8.3. This measurement represents the initial reading (see 6.4.2).
- b. Second and third heat cycle: Test condition J.
- c. Measurement after test: After completion of the cleaning process and following a stabilization period at room temperature the dc resistance shall be measured as specified in 4.8.3.

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4.8.10 Resistance temperature characteristic (see 3.14). Resistors shall be tested in accordance with MIL-STD-202-304. The following details and exceptions shall apply:

- a. Test temperature: In accordance with table IX.
- b. Accuracy of temperature measurement: Resistors shall be maintained for 30 minutes +90 minutes, -15 minutes within 3°C at each of the test temperatures listed in table IX. This tolerance shall be maintained on the established test temperatures.
- c. Mounting: Resistors shall be mounted on a test board as specified in 4.8.1.3.
- d. The DC resistance shall be measured in accordance with 4.8.3.
- e. As an option, the manufacturer may develop a control procedure for minimum stabilization times required for RTC testing. This procedure shall detail specific time elements required to reach thermal and electrical stability for specific part designs. Upon approval by the qualifying activity, the manufacturer may use this procedure for minimum stabilization times for RTC testing.

TABLE IX. Resistance temperature characteristic.

Sequence	Temperature <u>1/</u>
	°C
1	<u>2/</u> 25 ±3
2	-55 ±3
3	<u>2/</u> 25 ±3
4	125 ±3

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

- 1 - 2/ 25°C ±3°C
- 2 - 125°C ±3°C
- 3 - 2/ 25°C ±3°C
- 4 - -55°C ±3°C

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

4.8.11 Humidity (Steady State) (see 3.15). Resistors shall be tested at a humidity (steady state) condition of 85°C ±3°C, 85 percent ±5 percent relative humidity for a period 1,000 hours +96 hours, - 0 hours. The following details and exceptions shall apply:

- a. Mounting: Resistor sample units shall be mounted on a test board as specified in 4.8.1.3.
- b. Conditioning: The specimens shall be conditioned in a dry oven at a temperature of 40°C ±5°C for a period of 24 hours.
- c. Initial measurement: Immediately following the initial conditioning period, dc resistance of each resistor on the test board shall be measured as specified in 4.8.3.
- d. The loading voltage shall be that which produces 10 percent of the rated power.
- e. Measurements at high humidity: None.
- f. Final measurements: Upon completion of the test, the resistors shall be removed from the chamber and air dried for a minimum of 15 minutes. The dc resistance shall then be measured within 48 hours of test completion in accordance with 4.8.3.

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4.8.12 Life test (see 3.16). Resistors shall be tested in accordance with MIL-STD-202-108. The following details and exceptions shall apply:

- a. Mounting: Resistor shall be mounted on an appropriate test board(s) (see 4.8.1.3).
- b. Initial measurement: The initial dc resistance shall be measured at room temperature (see 4.8.3) after mounting of the resistors under test. This measurement shall be used as the reference temperature for all subsequent measurements under the same condition.
- c. Operating conditions: One-time rated power shall be applied to the resistors intermittently, one and one-half hours "on" and one-half hour "off", for 2000 hours (+96 hours/-24 hours). During the "on" cycle, the power shall be regulated and controlled to within +/-5 percent.
- d. Terminal temperature: Terminal temperature shall be as specified (see 3.1) during the power on state. The combination of PCB design (e.g., solder pad thickness, geometry, part to part spacing, heat sinks, etc.) and the test environment (e.g., use of baffles, covers, temperature chambers) may be adjusted in order to achieve the specified terminal temperature.
 - (1) Terminal temperature shall be monitored (see 4.8.1.4) during the power on state using 1 or more thermocouples distributed among the devices under test and/or by thermal imaging techniques.
- e. Measurements during test: Following a minimum one hour stabilization period, dc resistance shall be measured as specified in 4.8.3 under the same test conditions used for the initial measurement.
 - (1) DC resistance shall be measured at the end of the 30 minutes "off" periods after 250 hours +72 hours, -24 hours; 500 hours +72 hours, -24 hours; 1,000 hours +72 hours, -24 hours; and 2,000 hours +96 hours, -24 hours have elapsed.

4.8.13 Solderability (see 3.17). Resistors shall be tested in accordance with MIL-STD-202-208. Both end terminations shall be immersed completely one at a time or both at the same time by dipping the entire resistor in the solder pot. The following details and exceptions shall apply:

- a. Apparatus:
 - (1) A solder pot capable of keeping the solder temperature to $\pm 5^{\circ}\text{C}$ of set point.
 - (2) A device to keep the specimen submerged in solder for the required time.
 - (3) Optical equipment capable of 30X magnification.
 - (4) A laboratory beaker or appropriate laboratory apparatus that is capable of:
 - (a) Supporting a nonmetallic device.
 - (b) Maintaining the test specimens at a distance of 1.50 inches (38.1 mm) to 2.50 inches (63.5 mm) from the surface of the boiling deionized water (DI) or distilled water while, at the same time, exposing them to the full flow of steam generated.
- b. The requirement for standard solderable wire application shall not apply.
- c. The immersion and emersion rates shall not apply.
- d. The specimen shall be totally submerged for at least 5 seconds.

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4.8.13.1 Solderability - alternate method (see 3.17.1). Resistors may be tested in accordance with [J-STD-002](#) test method S with category C preconditioning (i.e., 8 hours steam aging) may be used with the qualifying activity approval.

- a. Test substrate may be a PCB instead of a ceramic substrate at the discretion of the supplier.

4.8.14 Solder mounting integrity (see 3.18). The resistor shall be prepared as specified in 4.8.1.3a. A force shall be applied to all solderable units. The force shall be applied to the edge of the resistor as shown on figure 6 for a minimum of 30 seconds. The pusher width shall be a minimum of 100 percent of the resistor length (see 6.4.4). The applied force shall be as specified in table X.

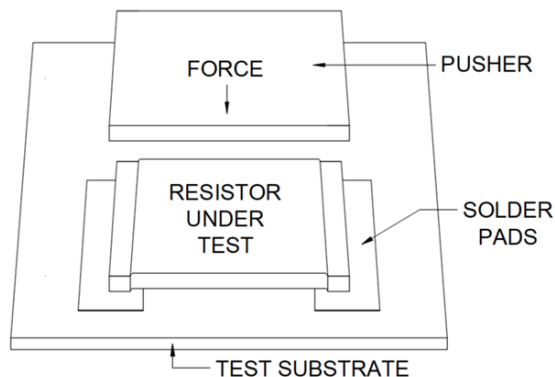


FIGURE 6. Solder mounting integrity test fixture.

TABLE X. Solder mounting integrity.

Style	Slash sheet	Force applied (kilograms)
RCKT1216	/7	1.8
RCST2512	/6	3
RCST2818, RCST3921 RCKT2726, and RCKT4026	/1, /2 /5 & /4	4
RCST5931	/3	5

4.8.15 Resistance to solvents (see 3.19). Resistors shall be tested in accordance with [MIL-STD-202-215](#). The following details and exceptions shall apply:

- a. Mounting: Unmounted.
- b. The marked portion of the resistor shall be brushed. Brushing is not required if the part has no marking.
- c. The number of sample units shall be as specified in [table IV](#) and [table V](#).

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4.8.16 Board flex (3.20). Resistors shall be tested in accordance with [MIL-STD-202-218](#) with these exceptions:

- a. Samples. Multiple samples may be tested on a single FR4 board.
- b. Duration of force: 60 seconds minimum while at maximum board deflection.
- c. Measurements during test: After a minimum of 60 seconds at maximum board deflection and while still flexed, resistance shall be measured in accordance with [4.8.3](#).

4.8.17 Laser marking legibility test (see 3.21). Resistors shall be coated with 0.005 inch (0.13 mm) minimum of silicon resin insulated compound, type SR of [IPC-CC-830](#). After curing, coated resistors shall be examined for legibility under normal production room lighting by an inspector at 10X magnification.

4.8.18 Outgassing (see 3.22). The resistors organic material shall be tested in accordance with [ASTM E595](#).

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 Service or Defense Agency, or within the military services 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.

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 offer very low resistance values having specified tolerances and are available in both 2-terminal and 4-terminal configurations. The performance specification provides resistance change limits under various environmental stress tests whereas the zero-ohm resistors (i.e., MIL-PRF-32159) only specify maximum resistance value. 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 should specify the following:

- a. Title, number, date of this specification, the applicable associated specification, and the complete PIN (see [1.2.1](#)).
- b. Unless 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](#)).
- d. If marking is required (see [3.26](#)).
- e. Allowable substitution (see [3.26.3](#))

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award or contract, qualified for inclusion in Qualified Products List QPL-32783 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 orders for the products covered by this specification. The activity responsible for the QPL, and information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQP, Post Office Box 3990, Columbus, Ohio 43218-3990 or by email to vqp.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

6.4 Application notes.

6.4.1 Tin whisker growth. The use of alloys with tin content greater than 97 percent, by mass, may exhibit tin whisker growth problems after manufacture. Tin whiskers may occur anytime from a day to years after manufacture and can develop under typical operating conditions, on products that use such materials. Conformal coatings applied over top of a whisker-prone surface will not prevent the formation of tin whiskers. Alloys of tin containing 3 percent or more lead, by mass, have shown to inhibit the growth of tin whiskers. For additional information on this matter, refer to [ASTM-B545](#) (Standard Specification for Electrodeposited Coatings of Tin).

6.4.2 Resistance to soldering heat. The initial resistance measurement will be taken after PCB mounting in preparation for the test. Because of the very low resistance values of this technology, this is done to accommodate shifts that may occur between unmounted measurement vs. mounted measurement as a result of differences in PCB materials, assembly profiles, and measurement systems.

6.4.3 Board Mount Resistance Shift. Designers are to be aware that the initial resistance value after mounting may not fall within the stated tolerance due to the same issues noted in 6.4.2. As a result, they are advised to evaluate the effects of their PCB materials, design, and assembly processes to assess this effect. In case of concerns, consult the manufacturer.

6.4.4 Solder mounting integrity pusher dimension. The solder mounting integrity test pusher dimension must be a minimum 100% of the resistor length to properly test the termination mounting integrity. Shorter pusher dimensions may result in distorting the resistor element which is not the purpose of this test.

6.5 Pulse application. Metal Strip resistors are capable of handling higher power pulse applications than traditional thick film. Per this MIL-PRF specification these resistors only see a five second short time overload (see [4.8.7](#)) as part of the group B inspection of this specification which does not represent all pulse handling capabilities of this technology. Designers are ADVISED for high power pulse applications to consult the manufacturer for specific pulse performance guidance and to perform in-situ testing.

6.6 Terminal Temperature Derating. Terminal temperature derating is a method of defining the power rating of an SMD resistor in terms of thermal dissipation performance, instead of ambient temperature conditions. The terminal temperature derating bases the 100% power rating of the SMD resistor on not exceeding a maximum resistance element temperature or hotspot of 170°C. By using the terminal temperature derating approach, the end user will be afforded the maximum performance capabilities for each design, construction and resistance value as opposed to historical derating methods based solely on ambient temperature and applied power. It enables end users to plan for the thermal dissipation of the system.

6.6.1 Using terminal temperature derating. Terminal temperature derating requires the end user to design their system to ensure that the specified terminal temperature is not exceeded.

6.6.2 Terminal temperature measuring points (see [4.8.1.4](#)). The measurement point for terminal temperature will vary depending on the lead configuration and is defined in the relevant slash sheet (see [3.1](#)). The terminal temperature measurement point is chosen as an accessible measurement point to then approximate the hot spot temperature based on thermal resistance of the resistor design and construction.

6.7 Subject term (key word) listing.

Low value
Two terminal construction
Kelvin termination (4-terminal)
Terminal temperature
Surface mount
Welded construction

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APPENDIX A

PROCEDURES FOR QUALIFICATION INSPECTION

A.1 SCOPE

A.1.1 Scope. This appendix covers the procedure for qualification inspection of resistors covered by this specification. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance only.

A.2 APPLICABLE DOCUMENTS. This section is not applicable to this document.

A.3 SUBMISSION

A.3.1 Product levels. Qualification of the C level is predicated upon meeting the M level qualification requirements. The procedure for submitting samples to become qualified to the M level is specified in [A.3.2](#). Qualification of the T (space) level is predicated upon meeting the M level (see A.4.1). The manufacturers shall use the existing M level design and meet the additional requirements for outgassing and the 100-cycle thermal shock test (see A.3.2).

A.3.2 Sample. A sample consisting of 232 sample units in each style for which qualification is sought, shall be submitted to group II, group III, group IV, group V, group VI, group VII, group VIII and group IX for qualification of [table IV](#). After qualification has been granted, no changes are to be made in materials, design, or construction without prior notification to the qualifying activity.

A.4 EXTENT OF QUALIFICATION

A.4.1 Extent of qualification. The extent of qualification between styles and shall be as specified in [table A-I](#).

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APPENDIX A

TABLE A-I. Extension of qualification.

Style	Slash sheet	Will qualify style <u>1/</u>
RCST2818	/1	RCST2818
RCST3921	/2	RCST3921
RCST5931	/3	RCST5931
RCKT4026	/4	RCKT4026, RCKT2726 <u>2/</u>
RCKT2726	/5	RCKT2726, RCKT4026 <u>2/</u>
RCST2512	/6	RCST2512
RCKT1216	/7	RCKT1216
Characteristic	Will qualify characteristic <u>1/</u>	
A	A, B, C, D, E, F, G, H, J, K, L, M	
B	B, C, D, E, F, G, H, J, K, L, M	
C	C, D, E, F, G, H, J, K, L, M	
D	D, E, F, G, H, J, K, L, M	
E	E, F, G, H, J, K, L, M	
F	F, G, H, J, K, L, M	
G	G, H, J, K, L, M	
H	H, J, K, L, M	
J	J, K, L, M	
K	K, L, M	
L	L, M	
M	M	
Resistance tolerance	Will qualify resistance tolerance	
0.1	0.1, 0.25, 0.5, 1.0, 2.0, 5.0	
0.25	0.25, 0.5, 1.0, 2.0, 5.0	
0.5	0.5, 1.0, 2.0, 5.0	
1.0	1.0, 2.0, 5.0	
2.0	2.0, 5.0	
5.0	5.0	
Product level	Will qualify product level	
T	T, M, C	
M	M, C	
C	C	

- 1/ The same design and technology must be utilized for the style qualified and the styles that the qualification is extended to.
- 2/ Qualification of RCKT2726 will qualify RCKT4026 and RCKT4026 will qualify RCKT2726 due to the exact same materials and ratings with the only difference being terminals bent inward vs. outward.

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APPENDIX B

VISUAL INSPECTION

B.1 SCOPE

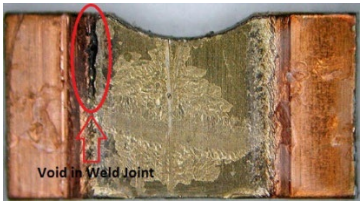
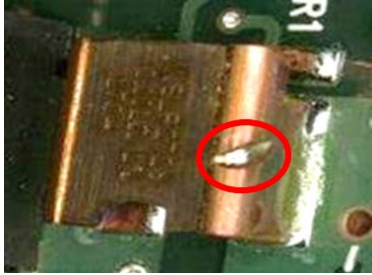
B.1.1 Scope. This appendix details the procedure for visual inspection of metal strip technology resistors covered by this specification. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance only.

B.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

B.3 INSPECTION

B.3.1 Pre-cap inspection and/or external visual for unencapsulated (bare) styles.

a) Reject if weld voids (see figure B-1a) or incomplete weld (see figure B-1b), totaling >5% of weld length.	 FIGURE B-1a. <u>Weld voids</u>.  FIGURE B-1b. <u>Incomplete weld</u>.
b) Reject if gouges or scratches whose depth is >50% of the material thickness (see figure B-2).	 FIGURE B-2. <u>Gouges or Scratches</u>.

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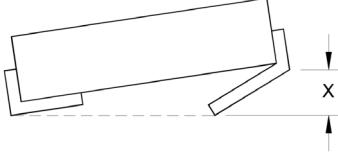
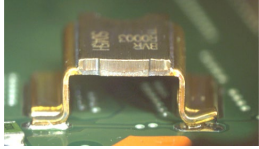
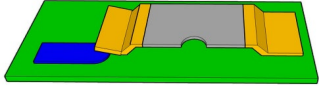
APPENDIX B

B.3.1 Pre-cap inspection and/or external visual for unencapsulated (bare) styles (continued).

c) Reject if dents with diameter $>0.015''$ (see figure B-3).	 FIGURE B-3. <u>Dents.</u>
d) Reject if areas of discoloration on a solderable surface $> 50\%$ (see figure B-4). If discoloration is attributable to a foreign material, then see paragraph B.3.3.	 FIGURE B-4. <u>Discoloration.</u>

APPENDIX B

B.3.2 Pre-cap inspection and/or external visual for encapsulated styles.

a) For molded encapsulation construction only, reject if >5% of the internal construction is visible through molding (see figure B-5).	 FIGURE B-5. <u>Internal construction is visible through molding.</u>
b) Reject if bottom terminals are not coplanar (see figure B-6). In case of dispute, coplanarity shall be measured using a shim (see Figure B-7b) that is the same thickness as the required stencil thickness per J-STD-002 Table 4-5 "Solder Stencil Thickness". Lie one terminal flat on a level surface. If the shim fits in the space under the other terminal "X", the terminals are considered bent. If the shim does not fit, the terminals are considered sufficiently level to be coplanar.	 FIGURE B-6. <u>Bottom terminals.</u>
a) Reject if device is not coplanar (see figures B-7a, B-7b, B-7c & B-7d: In case of dispute, coplanarity shall be measured using a shim that is the same thickness as the required stencil thickness per J-STD-002 Table 4-5 "Solder Stencil Thickness". Lie one terminal flat on a level surface. If the shim fits in the space under the other terminal, the terminals are considered bent. If the shim does not fit, the terminals are considered sufficiently level to be coplanar.	 FIGURE B-7a. <u>Not coplanar.</u>  FIGURE B-7b. <u>Not coplanar.</u>  FIGURE B-7c. <u>Not coplanar.</u>  FIGURE B-7d. <u>Not coplanar.</u>

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APPENDIX B

B.3.2 Pre-cap inspection and/or external visual for encapsulated styles (continued).

- b) For plated terminal constructions only, reject if > 5% bare metal showing on terminals (only applicable to solderable surfaces) (see figure B-8).

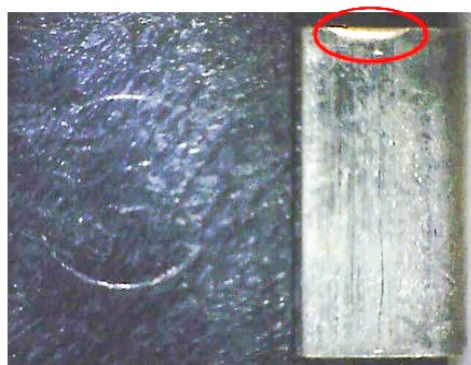


FIGURE B-8. Bare metal showing on terminals.

B.3.3 General criteria for foreign or extraneous material. For the purpose of this inspection, foreign material is defined as any material that is not a material used in the construction of the resistors. With the exception of light metal marks (defined below), extraneous material is a material used in the construction of the resistor that is not in its intended location by design. Material that can be removed with a soft bristled brush or a nominal gas blow (of 20 psig) of dry nitrogen or air is not rejectable.

- a) Reject attached foreign and/or extraneous material on any surface that reduces the separation between terminals to be less than 50% of the full width (d) (see figure B-9a & figure B-9b).

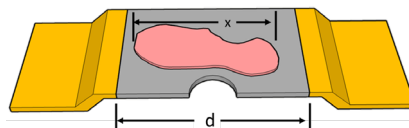


FIGURE B-9a. Reject $x/d > 0.5$.

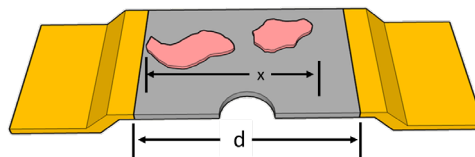


FIGURE B-9b. Reject $x/d > 0.5$.

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APPENDIX B

- b) Reject attached foreign and/or extraneous material occurring on greater than 10 percent of any homogeneous material surface (see figure B-10).

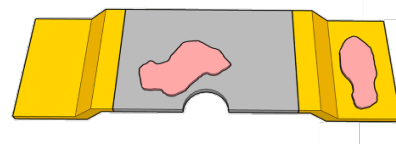


FIGURE B-10. Greater than 10 percent of surface area of a homogenous material.

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Custodians:

Army - CR
Navy - EC
Air Force - 85
NASA – NA
DLA – CC

Preparing activity:

DLA - CC

(Project 5905-2025-025)

Review activities:

Army - AR, AT, AV, CR4
Navy - AS, CG, MC, OS
Air Force - 19

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