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5 September 1984

MILITARY SPECIFICATION

INSULATION SHEET, ELECTRICAL, SILICONE RUBBER THERMALLY CONDUCTIVE, FIBERGLASS REINFORCED

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

1. SCOPE

1.1 Scope. This specification describes a fiberglass reinforced elastomeric sheet material which exhibits good electrical insulating properties and high thermal conductivity for transferring heat generated by semiconductor devices to external heat sinks.

1.2 Classification. The material shall be of the following types and classes, as specified:

Type I - Filled silicone rubber, glass reinforced, NASA outgassing approved.

Type II - Filled silicone rubber, glass reinforced, not NASA outgassing approved.

Type III - Filled silicone rubber, glass reinforced, pressure sensitive adhesive coating on one surface.

Type IV - Filled silicone rubber, glass reinforced, pressure sensitive adhesive coating on both surfaces.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Laboratory Command, Reliability, Logistics and Standardization Div., ATTN: SLCET-R-S, Fort Monmouth, NJ 07703-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5970

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Grade 1 - Thermal interface impedance of less than 0.25 $^{o}C-in^{2}/W$

Grade 2 - Thermal interface impedance from 0.26 to 0.35 $^{o}C-in^{2}/W$

Grade 3 - Thermal interface impedance from 0.36 to 0.50 $^{o}C-in^{2}/W$

Grade 4 - Thermal interface impedance from 0.51 to 1.00 $^{o}C-in^{2}/W$

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2 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 are those cited in the solicitation.

LAWS AND REGULATIONS

U. S. POSTAL SERVICE MANUAL

(Copies of the manual may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.)

PUBLICATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA SP-R-0022 - Vacuum Stability Requirements of Polymeric Material for Spacecraft Application.

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(Application for copies should be addressed to National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, TX 77058.)

2.2 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 which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies, Test for (DoD Adopted)

ASTM D150 - A-C Loss Characteristics and Permittivity, (Dielectric Constant) of Solid Electrical Insulating Materials, Test for (DoD Adopted)

ASTM D257 - D-C Resistance or Conductance of Insulation Materials, Test for (DoD Adopted)

ASTM E595 - Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment, Test for

ASTM D618 - Conditioning Plastics and Electrical Insulating Materials for Testing, Standard Methods of (DoD Adopted)

ASTM D624 - Rubber Property - Tear Resistance, Test for (DOD Adopted)

ASTM D792 - Specific Gravity and Density of Plastics by Displacement, Test for (DoD Adopted)

ASTM E1225 - Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique, Test for

ASTM D1458 - Fully Cured Silicone Rubber-Coated Glass Fabric and Tapes for Electrical Insulation, Test for

ASTM D2137 - Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics, Test for (DoD Adopted)

ASTM D2240 - Rubber Property - Durometer Hardness, Test for (DoD Adopted)

ASTM D3330 - Peel Adhesion of Pressure-Sensitive tape at 180-Degree Angle, Test for (DoD Adopted)

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ASTM D3951 - Standard Practice for Commercial Packaging (DoD Adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1137.)

UNDERWRITERS LABORATORIES, INC.

UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances (DoD Adopted)

(Application for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

(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.)

2.3 Order of precedence. In event of a conflict between the text of this specification and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), the text of this document takes precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified, samples shall be subjected to first article inspection (see 4.3 and 6.2).

3.2 Material. The sheet shall be fabricated of a single-ply of woven glass fabric, impregnated with and bonded between two essentially equal thickness layers of a silicone elastomer binder with filler providing thermal and electrical performance characteristics suitably cured to produce a product meeting the requirements of this specification. Sheet material shall be inherently non-nutritious to fungus.

3.2.1 Adhesive coating. For types III and IV the adhesive coating shall consist of a silicone or acrylic pressure sensitive adhesive. All adhesive coatings shall be provided with protective liners of polyethylene, polypropylene, or polyester film.

3.3 Performance and product characteristics. The performance and product characteristics of the glass reinforced silicone rubber insulating material shall be as specified in Table I.

3.3.1 Sheet dimensions.

3.3.1.2 Thickness. Sheet thickness shall be as specified by the Part or Identifying Number (PIN) (see 6.7) in the solicitation or contract (see

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Table I - Performance and product characteristics.

Characteristic	Requirement	Test reference
Specific gravity	1.35 to 3.20	4.5.2
Hardness, shore A (maximum)	95	4.5.3
Tear Strength, lb/in. (minimum)	100	4.5.4
Continuous-use temperatures, °C	-55 to 200	4.5.5
Dielectric breakdown voltage, V/mil (minimum) Normal Moist	 250 125	4.5.6
Dielectric constant @ 1 MHz & 100V (maximum)	6.0	4.5.7
Thermal vacuum weight loss, percent (maximum, Type I only)	1.0%	4.5.8
Volatile condensable material, percent (max., Type I only)	0.1%	4.5.8
Volume resistivity, megohm-cm (min) Normal Moist	 1×10^6 1×10^3	4.5.9
Thermal interface impedance, °C-in²/Watt Grade 1 Grade 2 Grade 3 Grade 4	 Less than 0.25 0.26 to 0.35 0.36 to 0.50 0.51 to 1.00	4.5.10
Adhesive peel strength, (Types III & IV only) as supplied, grams/mm ±3 after conditioning 4 days at 65°C, 80% relative humidity, grams/mm (min)	 9 6	4.5.11
Flame Resistance	94V-0	4.5.12
Color	Optional	4.5.13

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6.2). Tolerance for sheets with thickness of less than .020 inch is ±.002 and for sheets with thickness above .020 inch tolerance is ± 10 per cent. Thickness of types III and IV shall be measured with protective liners removed.

3.3.1.3 Width and length. Unless otherwise specified (see 6.2), the width and length of sheets shall be 16 inches. Tolerance for width and length shall be ± 1/32 inch.

3.3.2 Thermal vacuum weight loss and volatile condensable material content. Type I shall conform to the requirements of NASA SP-R-0022 when tested in accordance with 4.5.8.

3.3 Workmanship. The workmanship shall be such as to provide a product which is uniform and free of voids, contamination, ruptured glass, or other defects that would affect the properties of the material.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

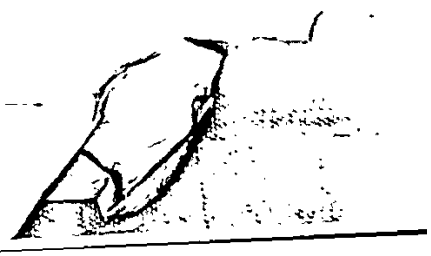
4.1.1 Responsibility for compliance. All items must meet all requirements of section 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

a. First article inspection (see 4.3)

b. Quality conformance inspection (see 4.4)

4.2.1 Inspection conditions.



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4.2.1.1 Temperature. Unless otherwise specified herein or in an applicable test method referenced herein, all inspections shall be performed at a temperature of 23 °C plus or minus 5 °C.

4.2.1.2 Conditioning specimens prior to test. Unless otherwise specified herein or in an applicable test method referenced herein, specimens of the material shall be conditioned in accordance with ASTM D618, Procedure A, prior to test.

4.3 First article inspection. When required (see 3.1 and 6.2), two (2) insulation sheet samples shall undergo all of the examinations and tests of 4.5. The sheets for first article inspection shall be selected at random from the first twenty (20) production sheets. Test report of first article inspection results shall be submitted in accordance with the written instructions of the Contracting Officer. Failure of insulation sheet specimens to meet requirements of Section 3 when examined and tested in accordance with 4.5 shall be cause for rejection of first article.

4.3.1 Prior approval. If a contractor has previously delivered an acceptable product meeting the requirements of this specification, First Article inspection may be waived at the discretion of the procuring activity for a period of time not to exceed 2 years.

4.4 Quality conformance inspection. Quality conformance inspections shall be as specified in Table II. The contractor shall maintain objective records of all inspections and tests and, upon request, the contractor shall make these records available for review by the Contracting Officer or his authorized representative.

TABLE II

INSPECTION OR TEST	REQUIREMENT	TEST METHOD
Dimensions	3.3.1	4.5.1
Specific Gravity	TABLE I	4.5.2
Hardness	TABLE I	4.5.3
Tear Strength	TABLE I	4.5.4
Dielectric Breakdown Voltage	TABLE I	4.5.6
Volume Resistivity	TABLE I	4.5.9
Thermal Interface Impedance	TABLE I	4.5.10
Peel Strength (Types III & IV)	TABLE I	4.5.11
Visual	3.3	4.5.13

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4.4.1 Acceptance and rejection criteria. Acceptance and rejection criteria for the examinations and tests of 4.4 shall be as specified in the acquisition document (see 6.2).

4.5 Inspections and test.

4.5.1 Sheet dimensions. Sheet thickness shall be determined in accordance with ASTM D1458, Section 5. Width and length shall be determined using a steel scale or other method of acceptable accuracy.

4.5.2 Specific gravity. Specific gravity shall be measured in accordance with ASTM D792.

4.5.3 Hardness. Hardness shall be measured in accordance with ASTM D2240.

4.5.4 Tear strength. Breaking shall be measured in accordance with ASTM D624, using die C.

4.5.5 Temperature.

4.5.5.1 High temperature. A insulation sheet specimen of at least 6 square inches in surface area shall be clamped finger-tight between aluminum plates and conditioned for seventy (70) hours ±1 hour at 200°C ± 3°C. Examination for decomposition shall be made immediately upon removal from the oven. Within one (1) hour after removal from oven and cooling to 23°C ± 3°C, the dielectric breakdown voltage of the specimen shall be measured in accordance with ASTM D149, Short Time Test, to determine compliance with the 250 V/mil requirement of Table I. Rate of voltage rise shall not be less than 500 V/S.

4.5.5.2 Low temperature brittleness. Low temperature brittleness shall be determined in accordance with ASTM D2137, procedure B, at a temperature of -55°C ± 1°C. Breaking or cracking of any specimen shall result in failure of this test.

4.5.6 Dielectric breakdown voltage. Dielectric breakdown voltage shall be measured in accordance with ASTM D149, Short-time Test, using a type 1 electrode (2 inch). Rate of voltage rise shall not be less than 500 V/S. Five tests shall be performed with insulation sheet specimens conditioned in accordance with 4.2.1.2 (normal). Five tests shall also be performed with insulation sheet specimens which have been conditioned in accordance with ASTM D618, Procedure D, (moist).

4.5.7 Dielectric constant. The dielectric constant of the insulation sheet shall be measured in accordance with ASTM D150. Three insulation sheet specimens shall be tested. The average dielectric constant shall be determined from the three results and used for determining compliance with the requirement of Table I.

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4.5.8 Thermal vacuum weight loss and volatile condensable material content for Type I. The thermal vacuum weight loss and volatile condensable material content of Type I sheet material shall be measured in accordance with ASTM E595. Test pressure shall be 1 X 10^{-6} torr or less.

4.5.9 Volume resistivity. The volume electrical resistivity shall be measured in accordance with ASTM D257. Specimens for the moist condition test shall be conditioned prior to test in accordance with ASTM D618, Method D.

4.5.10 Thermal interface impedance. Thermal interface impedance shall be determined by method A (4.5.10.1) or method B (4.5.10.2).

4.5.10.1 Method A.

4.5.10.1.1 Apparatus. The general features of the apparatus are shown in figure 1. All contacting surfaces shall be smoothly finished to within 16 microinches (0.4 micrometers) so as to approximate a true plane for the meter bars in contact with the specimen surface. A List of the basic components required for determination of thermal impedance is as follows:

a. Heater - A block of copper or other highly conductive material, into which wire wound cartridge heaters are inserted. This block is thermally insulated by a 5 mm layer of epoxy FR-4 or similar material. Outside this layer is a guard heater of similar construction to thermally insulate the heater from the press and ensure that all heat is transferred to the upper meter bar.

b. Meter bars - Two meter bars constructed from high thermal conductivity material having parallel working surfaces and good surface finish. A suitable material of construction is a high purity grade aluminum.

c. Reference calorimeter - A reference calorimeter constructed from a material which has a well characterized thermal conductivity over the range of test temperatures to be used. A recommended material is SRM-1462 austenitic stainless steel. A list of other useful materials of construction is in ASTM E 1225.

d. Cooling unit - The cooling unit is a metal block cooled by fluid supplied from a constant temperature bath such that the temperature is maintained uniform at $\pm$ 0.2 °C.

e. Press - A press capable of transmitting the specified force to the test fixture through a free-floating spherical seat attachment, preventing offset loads and uneven pressures on the test specimen.

f. Insulation - A fibrous thermal insulating blanket.

4.5.10.1.2 Procedure.

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4.5.10.1.2.1 Specimen. A test specimen shall be prepared from the insulation sheet sample of the same area (length and width) as the meter bars. The specimen shall be tested in the as-received state. Any obvious contamination shall be removed by a suitable, non-reactive solvent prior to testing. Any cleaning shall be followed by drying procedures to assure the removal of all solvents.

4.5.10.1.2.2 Apparatus setup. The general arrangement of the components are illustrated in figure 1. Center the test specimen between the two meter bars and insert the reference calorimeter between the lower meter bar and the cooling unit. Place the assembled test stack into the press. Apply thermal insulation around the stack if measurements are to be made at temperatures above 27 °C. With the press, apply a force of 300 psi (2.07 MPa) of pressure to the stack. Circulate cooling fluid and apply power to the heating element. Maintain the temperature of the guard heater to within ± 0.2 °C of the heater. Continuously adjust the applied force in the press during heat-up to counter act the increased pressure on the specimen due to thermal expansion.

4.5.10.1.2.3 Measurement. Record the temperatures of the meter bars and the reference calorimeter at equilibrium. Equilibrium is attained when 2 successive sets of temperature readings are taken at 15 minute intervals and the differences between the two are observed to be within ± 0.2 °C.

4.5.10.1.3 Calculations.

4.5.10.1.3.1 Calculate heat flow from the reference calorimeter as follows:

$$Q = \frac{\lambda_s A}{X} \left[T_u - T_l \right]$$

where:
Q = heat flow in watts
λ_s = thermal conductivity of reference calorimeter, W/in °C
A = area of the reference calorimeter, square in.
T_u = upper temperature of calorimeter, °C
T_l = lower temperature of calorimeter, °C
X = distance between the reference calorimeter thermocouples, inches

4.5.10.1.3.2 Calculate the temperature of the upper meter bar as follows:

$$T_1 = T_s - \left[\frac{d_s}{d_A} (T_A - T_s) \right]$$

where:
T_1 = temperature of the upper meter bar, °C

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T_A = upper temperature of the upper meter bar, °C
T_B = lower temperature of the upper meter bar, °C
d_B = distance between thermocouples of upper meter bar, inches
d_B^A = distance from the lower thermocouple to the lower surface of the upper meter bar, inches

4.5.10.1.3.3 Calculate the temperature of the lower meter bar as follows:

$$T_A = T_C + \left[\frac{d_C}{d_D} (T_C - T_D) \right]$$

where:

T_A = temperature of the lower meter bar, °C
T_C = upper temperature of the lower meter bar, °C
T_D = lower temperature of the lower meter bar, °C
d_C^D = distance from the upper thermocouple to the upper surface of the lower meter bar, inches
d_D = distance between thermocouples of lower meter bar

4.5.10.1.3.4 Calculate thermal impedance as follows:

$$\theta = (T_1 - T_A) / q$$

where:

θ = thermal impedance, °C in²/W
q = rate of heat flow through the sample per unit area, Q/A

4.5.10.2 Method B.

4.5.10.2.1 Apparatus. List of basic components required for determination of thermal impedance is as follows:

a. Heater/sensor - an electrically insulated wire-wound coil for applying a measured quantity of heat energy into the assembly and a second winding used to sense the temperature in the assembly. It shall have parallel strands of 040 AWG copper wire having identical thermal resistance at 20 °C. The surface areas are closely matched. Details are illustrated in Fig 4.

b. Wheatstone bridge - is used for minimizing zero shifts caused by small increments in the temperature of the heat sinks. The bridge, illustrated in Fig. 3, uses an amplifier with a gain of 2000X. The bridge shall have a standardization resistor specific to the temperature

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coefficient of resistance of the heater/sensor strand wire.

c. Press - a spring loaded, screw thread, or hydraulic arbor press is used to maintain essentially constant force with changes in operating temperatures.

d. Sheet, thermally conductive - A thin, very resilient and flexible sheet material to cover the two sensors and minimize the strain sensitivity of the heater/sensors. A .1 inch (25 micrometer) polyester film is satisfactory for this material.

4.5.10.2.2 Procedure.

4.5.10.2.2.1 Specimens. Six pieces of material having an area greater than the heater/sensor shall be prepared from the insulation sheet sample. The six pieces shall be designated as the test specimen. The specimen shall be tested in the as-received state. Any obvious contamination shall be removed by a suitable, non-reactive solvent prior to testing. Any cleaning shall be followed by drying procedures to assure the removal of all solvents.

4.5.10.2.2.2 Apparatus setup. The general assembly of the apparatus is shown in figure 2. A schematic electrical layout is shown in figure 4. Place specimens in the assembly in accordance with configuration 1 of figure 2. With the press apply a force of 300 psi (2.07 MPa) to the system. Leave the specimen under this condition for a minimum of one hour.

4.5.10.2.2.3 Measurement. Turn on and zero the amplifier with the bridge power off. Turn the bridge power on and zero the bridge. Turn the bridge calibration switch on and record the change in the signal (V_c). Turn the bridge calibration switch off. Turn the power switches of the two heaters on. Introduce pieces of thin polymeric film into either cavity to achieve a small positive reading and record this reading as V_1. Rearrange the assembly in accordance with configuration #2, repeat the above operations, and record the small positive reading as V_2.

4.5.10.2.3 Calculations.

4.5.10.2.3.1 Calculate the "cell constant" of the wheatstone bridge assembly as follows:

$$\text{cell constant} = \left[\frac{2 A R_{BB} (R_{AJ})^2}{\alpha \; R_{HA} \; R_{SA} \; R_B \; (R_{AJ} + R_{AA})} \right]$$

where:

A = the area of one side of the heater/sensor.
α = the temperature coefficient of resistivity of the alloy of the sensor strand wire.

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R_{SA} & R_{SB} = the sensor electrical resistance (ohms).
R_{BB} = the bridge electrical resistance (ohms).
R_{AB}^{B} + R_{AA} = the electrical resistance of the calibration network (ohms).
R_{HA} = the electrical resistance of the heater at 0°C (ohms).
I_{HA} = the current in the heater winding (amperes).

4.5.10.2.3.2 Calculate the thermal impedance as follows:

$$\theta = \frac{(V_2 - V_1)\ \text{cell constant}}{V_c\ I^2}$$

where:

V_c, V_1, & V_2 = as recorded in 4.5.2.2.3.2
I_c = current in the heater winding, (amperes).
θ = thermal impedance, °C in²/W

4.5.11 Peel strength. The peel strength shall be measured in accordance with ASTM D3330, Method A.

4.5.12 Flame Resistance. The flame resistance of the insulation sheet material shall be determined in accordance with UL 94.

4.5.13 Visual Examination. The material shall be visually examined for conformance to 3.4. Unless otherwise specified, visual examination shall be conducted with the unaided eye, except for normal corrected vision.

4.6 Examination of Preservation, Packaging, Packing, and Marking. An examination shall be made to determine that preservation, packaging, packing, and marking comply with Section 5 requirements and the specifications, standards, regulations, and publications referenced therein or as otherwise specified in the acquisition document (see 6.2). Examination shall be in accordance with the list below.

Examine	Defect
Marking	Omitted; incorrect; illegible; of improper size, location, sequence, or method of application.
Workmanship	Inadequate application of components, such as incomplete closure of container flaps, loose strapping or taping, inadequate stapling. Bulged or distorted container.
Materials	Not in accordance with applicable specifications, standards, regulations and publications referenced in Section 5.

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5. PACKAGING

5.1 Preservation and packaging. The insulation sheets shall be preserved and packaged in accordance with ASTM D3951 in a manner which will insure adequate protection against deterioration and damage during shipment from the supply source to the first receiving activity for immediate use.

5.2 Packing. The insulation sheets packaged as specified in 5.1 shall be packed in containers which will insure acceptance by common carrier at the lowest rates and safe delivery at destination. Packing shall comply with U. S. Post service Manual, Uniform Freight or National Motor Freight Classification Rules and Regulations, as applicable.

5.3 Marking. In addition to any marking specified in the contract or order, unit packages and shipping cartons shall be marked in accordance with MIL-STD-129 and shall include the following:

a. This specification number and revision level.

b. Material identification number and name.

c. Manufacturer's name and address.

d. Manufacturer's designation.

e. Lot or batch number.

f. Date of manufacture.

g. Date of shipment from manufacturer.

h. Material size, thickness, and number of sheets.

i. Purchase order number.

j. Test report number.

6. NOTES

6.1 Intended use. The material is intended to provide an electrically insulating but thermally conductive path, without the use of thermal grease, between heat-generating electrical or electronic parts and their heat sinks. Type I is intended for use in both aerospace and ground based equipments. Types II, III and IV are intended only for use in ground based equipments. This material is not for use on electronic assemblies that will be subsequently conformably coated with nonsilicone materials. Nonsilicone coatings will not adhere to the insulation sheet and thus, dielectric debris could be generated.

6.2 Acquisition requirement. Acquisition documents should specify the

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following:

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

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1, 2.1.2 and 2.2)

c. First article inspection, if required (see 3.1)

d. Part or Identifying number (PIN) (see 6.7).

e. Acceptance and rejection criteria (see 4.4.1) (paragraph 6.5 is included for guidance as an example of an appropriate sampling plan).

f. Number of sheets required.

g. Any special markings required.

h. Preservation and packaging, if other than as specified (see 5.1 and 5.2).

i. Sheet width and length, if other than specified.

j. Color, if required (see Table I).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.3	UDI-T-23790	Report, First Article Test	None

The above DID's were those cleared as of the date of this specification. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD form 1423.

6.3.1 Waiver of data requirements. The data requirements of 6.3 may be waived by the contracting officer upon certification by the offeror and acceptance of past procurement by the Government under a previous contract for

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an identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test data).

6.4 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection for those bidders offering a product which has been previously acquired or tested by the Government. Bidders offering such products, who wish to rely on such past production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.5 Acceptance and rejection criteria.

6.5.1 Sampling plan. Sampling for the examinations and tests of 4.4 shall be performed in accordance with MIL-STD-105. The inspection level shall be special inspection level S-3 and the acceptable quality level (AQL), expressed in terms of defects per hundred sheets of insulation sheet, shall be 4.0.

6.5.1.1 Inspection lot. The inspection lot shall consist of the quantity of material which has been subjected to physical mixing or chemical processing as a batch at one time and processed under essentially the same conditions to achieve a product with uniform characteristics.

6.5.2.2 Sample unit. The unit of sample shall be one sheet of the finished product. Each unit of sample (sheet) selected in accordance with 4.4.1 shall undergo the inspections and tests of table II.

6.6 Classification Change. Changes in classification between this revision and previous editions are as follows:

Old designation	New designation
Type II	Type III
Type III	Type IV
Class 1	Grade 1
Class 2	Grade 2 and Grade 3
Class 3	Grade 4

6.7 Cross-reference of PINs. Cross-reference of PINs between this revision and previous editions are as follows:

Superseded PIN MIL-I-49456	New PIN MIL-I-49456A
B49456-01-XX	M49456-11-XX
B49456-02-XX	M49456-12-XX and M49456-13-XX
B49456-03-XX	M49456-14-XX
B49456-04-XX	M49456-31-XX

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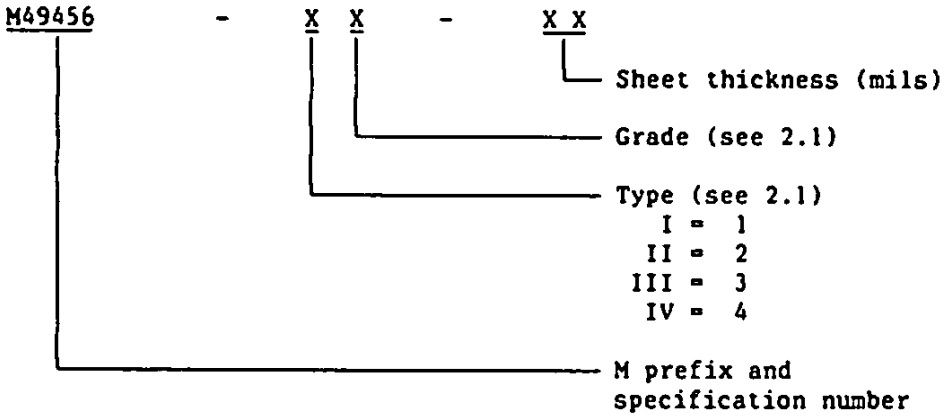
B49456-05-XX	M49456-32-XX and M49456-33-XX
B49456-06-XX	M49456-34-XX
B49456-07-XX	M49456-41-XX
B49456-08-XX	M49456-42-XX and M49456-43-XX
B49456-09-XX	M49456-44-XX

6.8 Part or Identifying Number (PIN). The PIN to be used for insulation sheets acquired to this specification are created as follows:



6.9 Subject term (key word) listing.

elastomer insulator
fiberglass reinforced elastomeric sheet
heat sink
silicone sheet
thermal interface material
thermally conductive insulators

6.10 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.

6.11 Hazards. This specification may involve hazardous materials, operations, and equipment. This specification does not purport address the safety problems associated with its use. It is the responsibility of the insulation sheet supplier or test activity to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitation which may apply.

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Custodians:

Army - ER
Navy - EC
Air Force - 85

Review activities:

DLA - GS
Army - ER
Navy - EC
Air Force - 85

Preparing activity:

Army - ER

Agent:

DLA - GS

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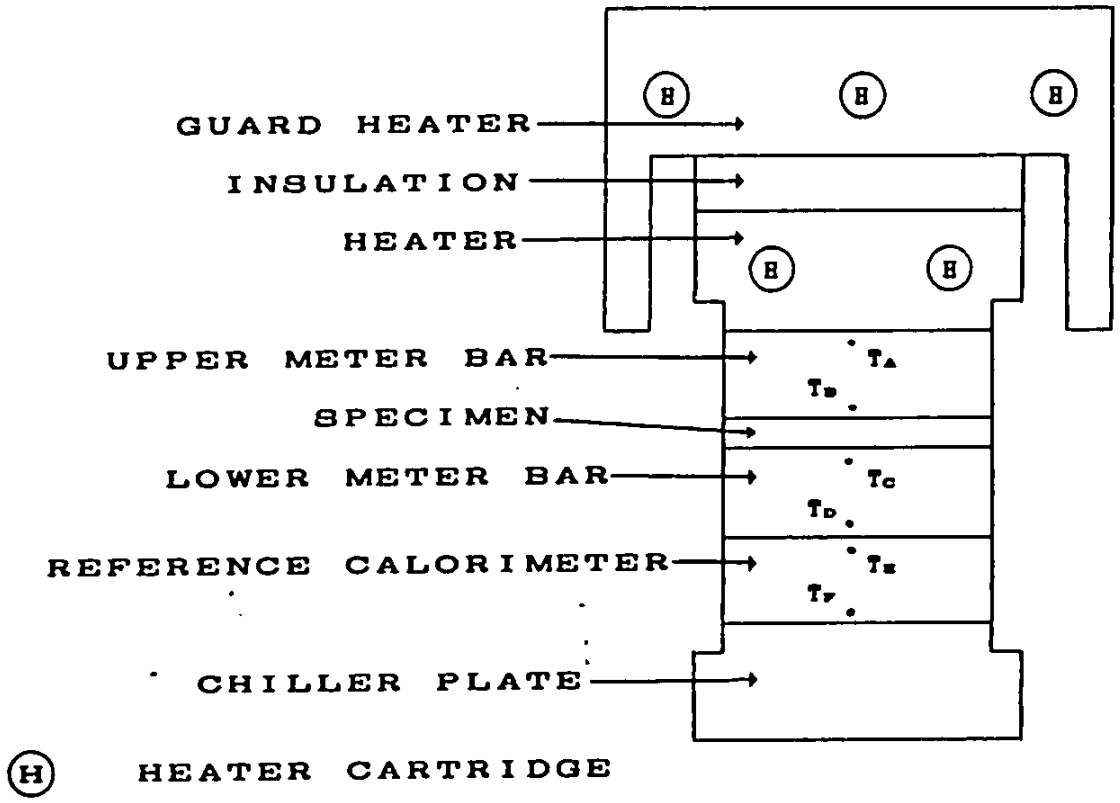

T_A through T_F represent temperature measuring points.

FIGURE 1. Test fixture - Method A.

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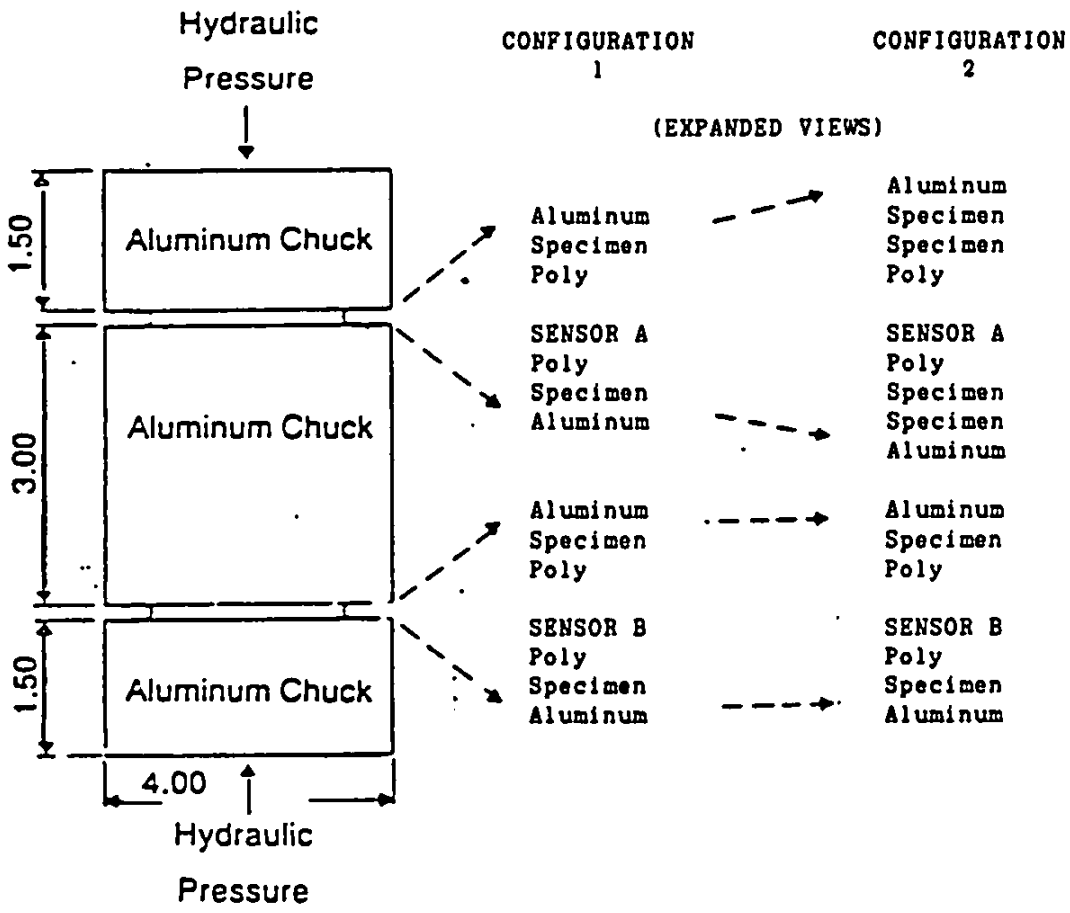

FIGURE 2. Test fixture - Method B.

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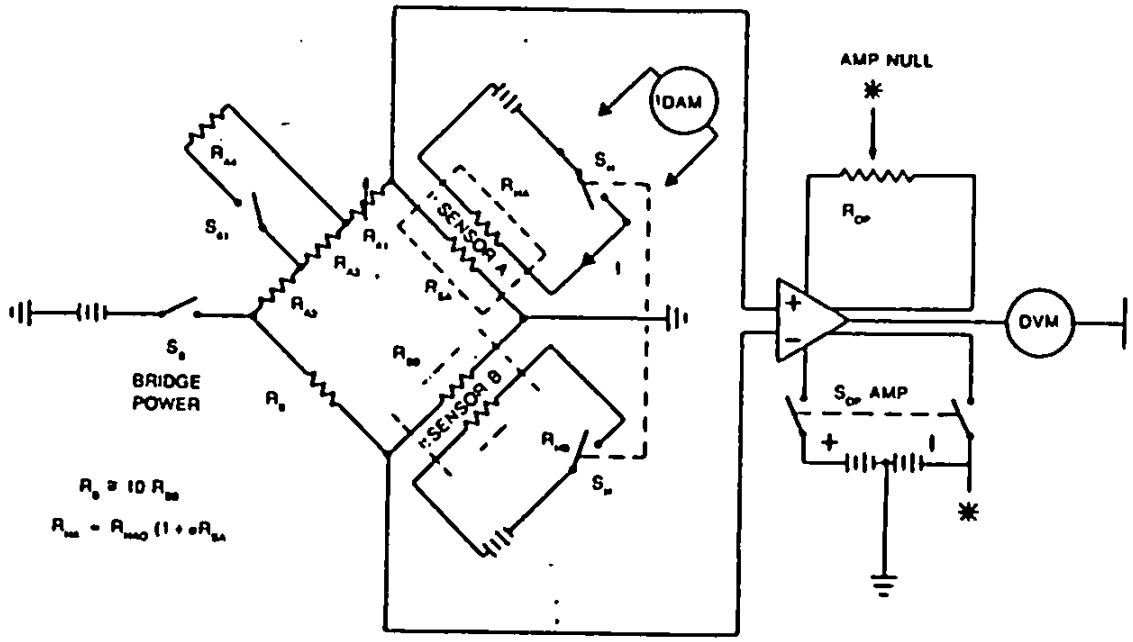

FIGURE 3. Electrical schematic - Method B.

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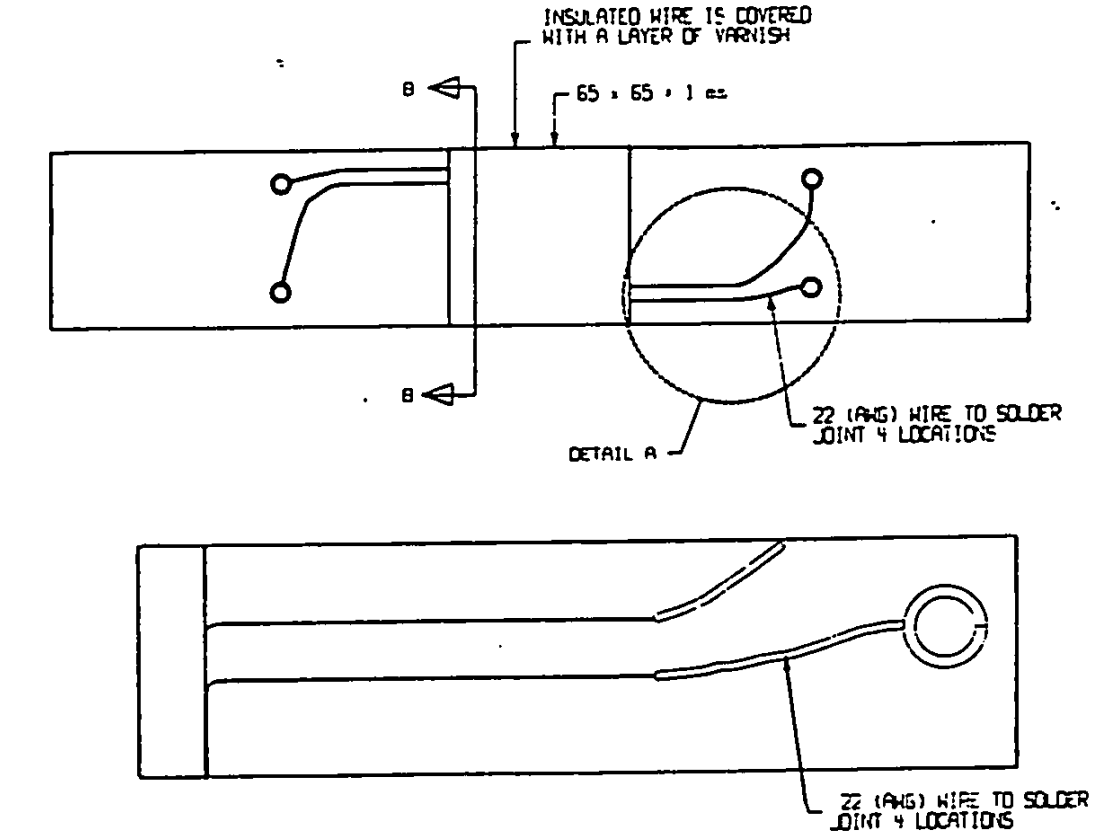

NOTES:

1. DOUBLE COATED WITH A SOLVENT SENSITIVE (ALCOHOL) TOP COATING FOR BONDING TO THE SUPPORT AND THE ADJACENT WIRE
• 40 OR • 41 FORMVAR #1. MWS WIRE INDUSTRIES

FIGURE 4. Heater/Sensor - Method B.

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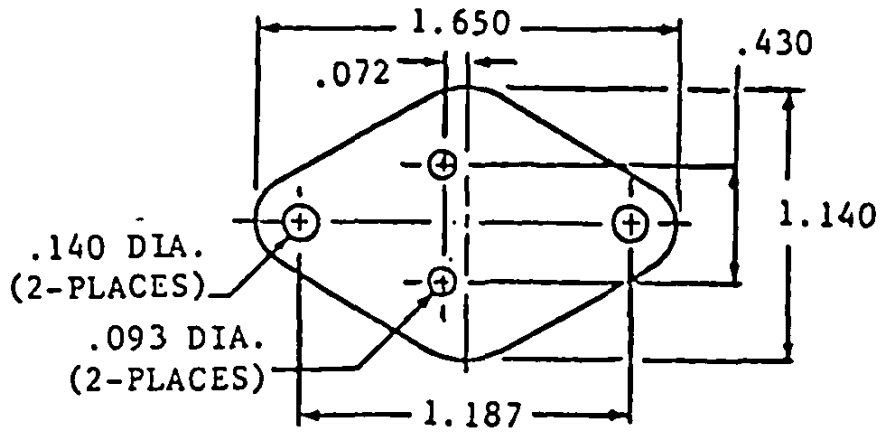

Inches	mm
.072	1.83
.093	2.36
.140	3.56
.430	10.92
1.140	28.96
1.187	30.15
1.650	41.91

NOTES:

1. Dimension are in inches.
2. Metric equivalents (to the nearest .01) are given for general information only and are based upon 1 inch = 25.4 mm.
3. Tolerances are ±.015 (.38 mm) except ±.010 (.25mm) on hole diameters.

FIGURE 5. Sample.

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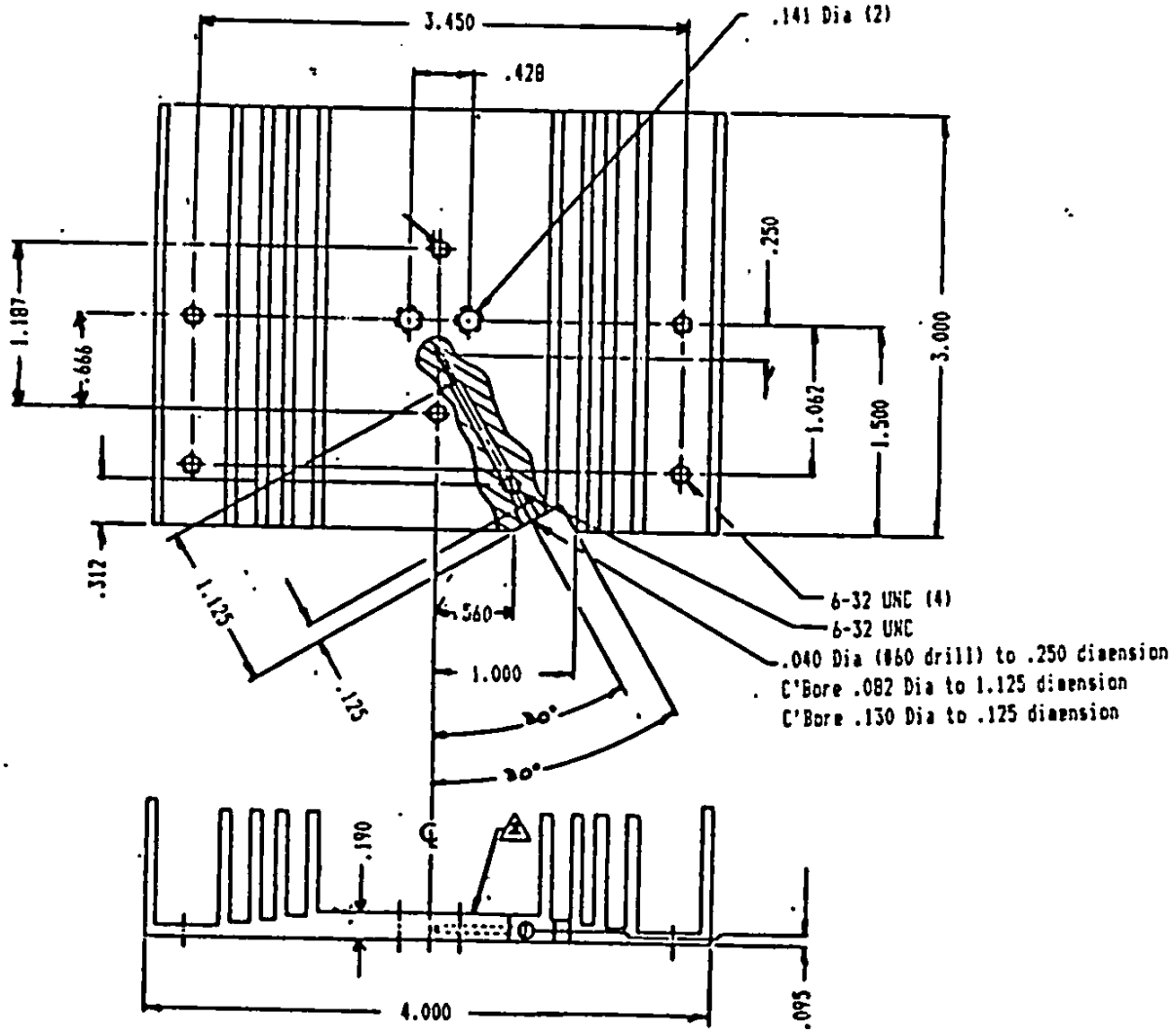

NOTES:

1. Make from Avvid extrusion 61030.
2. Surface to be flat within .0005.
3. Diaension are in inches.
4. Metric equivalents (to the nearest .01) are given for general inforaation only and are based upon 1 inch = 25.4 aa.
5. Tolerances are ±.015(.38 aa), ±.010 (.25aa) on hole diaaeters.

Inches	aa	Inches	aa	Inches	aa
.040	1.02	.190	4.83	1.125	28.58
.082	2.08	.250	6.35	1.187	30.15
.095	2.41	.312	7.92	1.500	38.10
.125	3.18	.560	14.22	3.000	76.20
.130	3.30	.666	16.92	3.450	87.63
.141	3.58	1.000	25.40	4.000	101.60
.143	3.63	1.062	26.97		

FIGURE 6. Heat sink.

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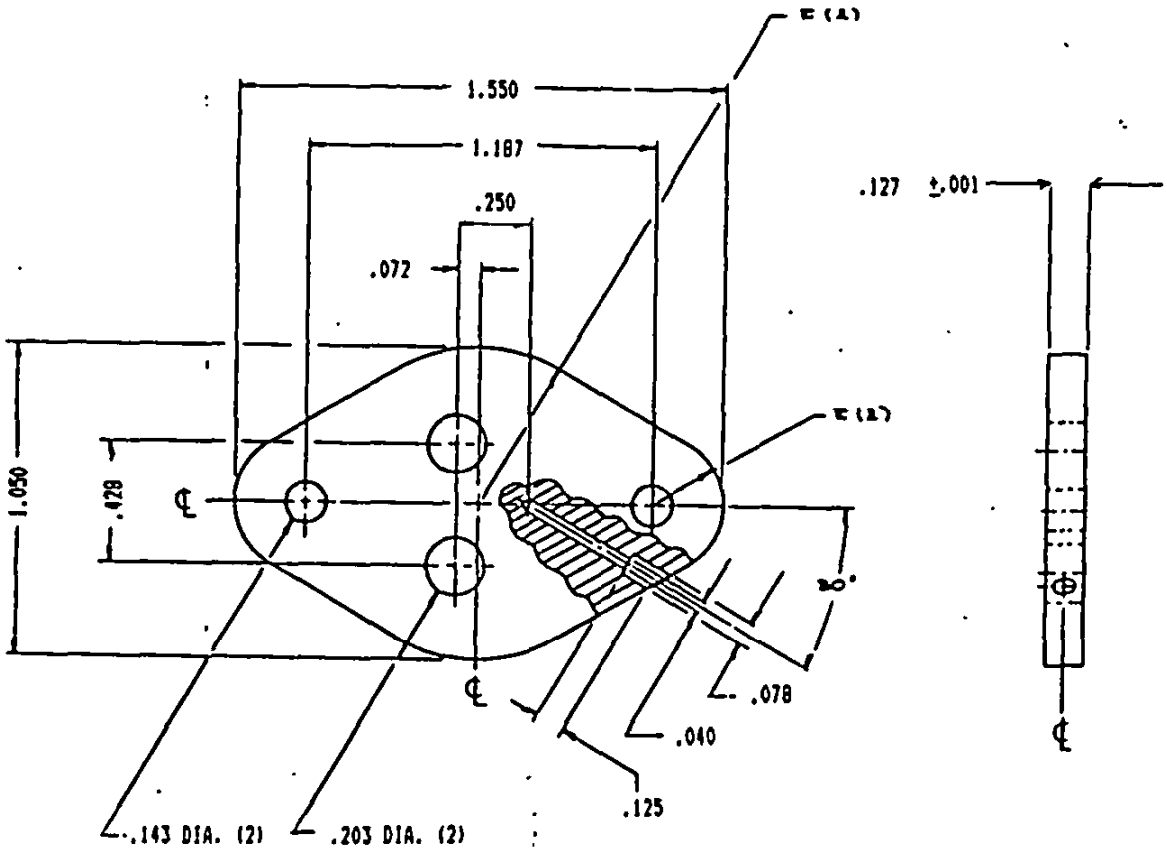

NOTES:

1. Dimension are in inches.
2. Metric equivalents (to the nearest .01) are given for general information only and are based upon 1 inch = 25.4 mm.
3. Tolerances are ±.015 (.38 mm), ±.010 (.25mm) on hole diameters, unless otherwise specified.
4. Materials: Aluminum, QQ-A-250/11, 6061-T6.
5. Remove all burrs and sharp edges.

Inches	mm
.040	1.02
.072	1.83
.078	1.98
.125	3.18
.127	3.23
.143	3.63
.203	5.16
.250	6.35
.428	11.13
1.050	26.67
1.187	30.15
1.550	39.37

FIGURE 7. Spacer.

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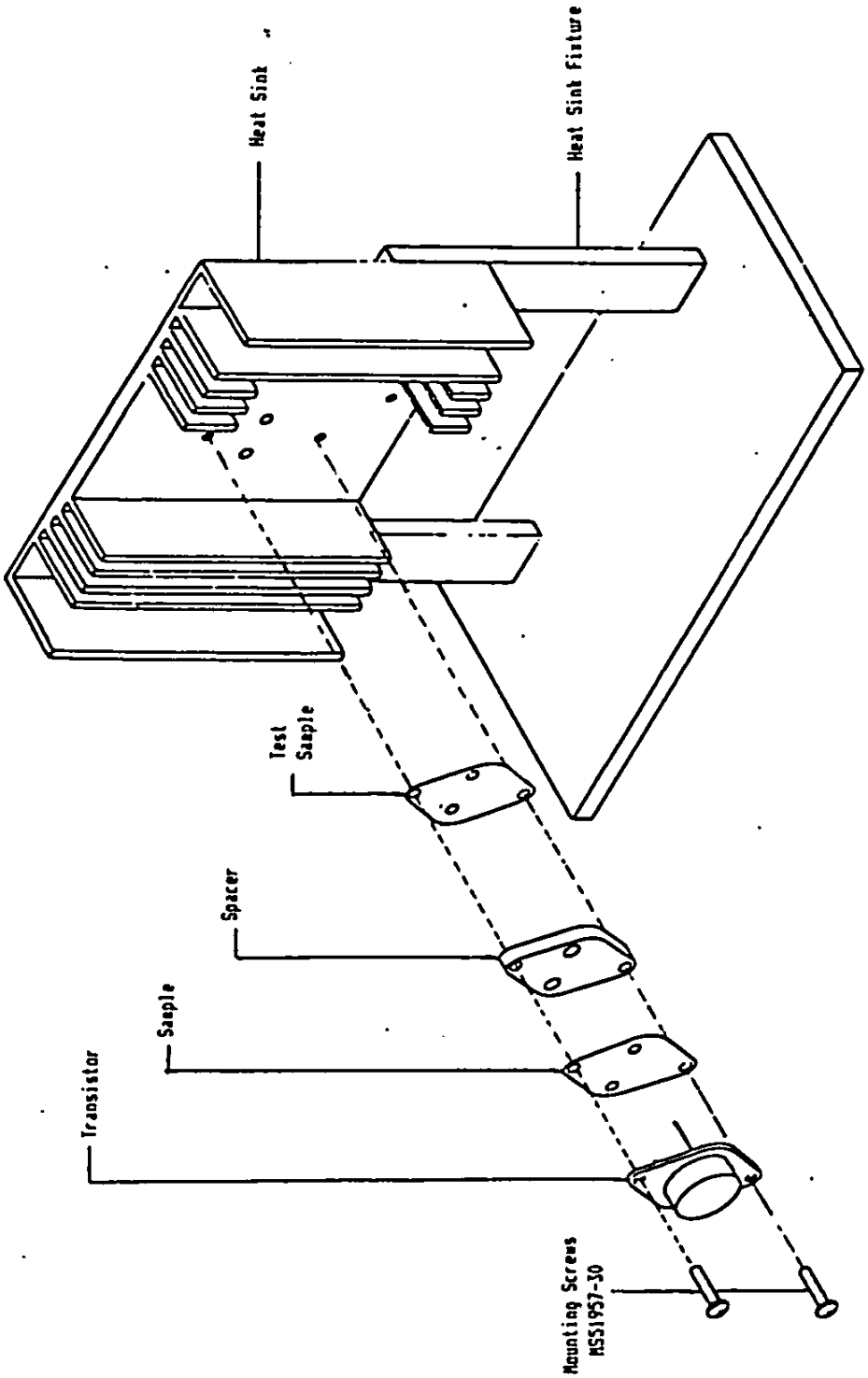

FIGURE 8. Test fixture assembly.

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APPENDIX

TO-3 Method for Comparative Thermal Impedance Measurements

10. SCOPE

10.1 Scope. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only. It details a simple and economical means of estimating the range in which the thermal impedance of a material falls, or comparing thermal impedances of different materials. The values obtained apply only to the specific test setup used; such values are not expected to be reproducible between laboratories. Since absolute values are not developed, this method is not appropriate for situations where a specific thermal impedance is needed, such as in Government acquisitions of insulating materials.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST METHOD

30.1 Sample preparation. Using the dimensions of figure 5, prepare the samples needed from a sheet of the material to be tested.

30.2 Equipment. Basic equipment required is as follows:

a. Power supply. A DC power supply regulated to supply 0-30V at 0 to 8 amp. A circuit is needed to supply base current for transistor control. An ammeter and voltmeter are needed to measure power (see 30.3.5) with a precision of ±5%.

b. Temperature indicators. No. 30 to No. 36 AWG thermocouples and a potentiometric measurement system capable of measuring a differential of ±0.2 °C, repeatable to ±0.1 °C.

c. Enclosure. A test enclosure approximately 1 ft. cubed in size is needed to establish a 30 °C ambient air temperature around the heat sink.

d. Heat sink. A heat sink for TO-3 case style, 56 sq. in surface area is needed. As shown in figure 6, a hole is drilled so the thermocouple can be placed in accordance with the transistor hot spot.

e. Spacer. Dimensions are shown in figure 7.

f. Fixture. As shown in figure 8, a fixture is needed to position the heat sink in center of the test enclosure.

g. Torque screw driver. One having a range of 2 to 10 inch-pounds with

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accuracy of ±3%.

h. Transistors, TO-3 case, audio amplifier, 30 W capability at 120 °C (Example: 2SD733)

30.3 Procedure.

30.3.1 Cleaning of parts. Clean the heat sink, spacer, bottom of transistor, and fasteners to remove grease and dirt, and any particles from previous tests. Note that foreign matter on surfaces and threads of fasteners can affect the test pressure and cause inconsistent results.

30.3.2 Equipment set-up. Assemble heat sink to heat sink fixture. Assemble transistor, spacer, and test samples to the heat sink as shown in figure 8. Tighten the screws alternately and evenly to a torque of 5 to 7 inch-pounds. Insert thermocouple junctions into holes drilled in the spacer and heat sink, assuring that the junction reaches the end of the hole. Connect the thermocouple leads to the temperature indicators. Connect the d-c power source and the control (base) circuit, and cover the assembly with the test enclosure.

30.3.3 Operation. Adjust the power to 30 watts as calculated in 30.3.5 The control (base) circuit will require adjusting, since the resistance of the transistor will change as a stable temperature is reached. Allow the operating test fixture to stabilize as indicated by stable temperature, voltage, and current. Warning: Temperatures of 130 °C can be reached at the transistor.

30.3.4 Measurement. Measure and record the emitter current, collector to emitter voltage, and temperatures of the spacer and heat sink.

30.3.5 Calculations. Calculate thermal impedance as follows:

$$\frac{(T_s - T_h)}{W} = {}^\circ C/W \qquad W = I_E \times V_{EC} = \text{Power}$$

where:

T_s = temperature of spacer
T_h = temperature of heat sink
I_E = emitter current
V_{EC} = emitter to collector voltage
W = watts (power)
°C/W = thermal impedance

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Insulation Sheet, Electrical, Silicone Rubber Thermally Conductive Fiberglass Reinforced

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

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