

INCH-POUND

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SUPERSEDING

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(SEE 6.5)

MILITARY STANDARD

DESIGN REQUIREMENTS FOR
STANDARD ELECTRONIC MODULES



AMSC N/A

FSC 5963

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FOREWORD

1 This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2 Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Sea Systems Command, Code SEA5523, Department of the Navy, Washington, DC 20362-5101, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3 The purpose of this standard is to provide instructions to contractors and suppliers with respect to the requirements to be considered during the design of new modules for use in the Standard Electronic Modules (SEM) Program as part of the Standard Hardware Acquisition and Reliability Program (SHARP).

Requirements for employing Standard Electronic Modules (SEM) are specified in MIL-STD-1378. MIL-STD-1378 also specifies the procedures for recommending new modules for addition to the list of standard modules.

Modules designed in accordance with the requirements of this standard shall also meet the requirements of MIL-M-28787

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1. SCOPE

1.1 Scope. This standard establishes the design requirements for Standard Electronic Modules (SEM) for the Standard Hardware Acquisition and Reliability Program (SHARP) for use in military systems. Other requirements for new module development are specified in MIL-M-28787 for the appropriate class selected to meet the system/equipment environmental requirements.

1.2 Classification. SEM shall be of the following classes and formats as specified in the detail specifications:

Classes

- Class I - For primary utilization in shipboard, subsurface ship, and shore applications. Module interface temperature, rib surfaces or inlet air, at 0°C low, and 60°C high.
- Class II - For primary utilization in airborne applications and where stringent environmental requirements are imposed. Module interface temperature, rib surfaces or inlet air, at minus 55°C low, and 85°C high.
- Class III - For utilization where class I modules may be exposed to radiation. Module interface temperature, rib surfaces or inlet air, at 0°C low, and 60°C high.
- Class IV - For utilization where class II modules may be exposed to radiation. Module interface temperature, rib surfaces or inlet air, at minus 55°C low, and 85°C high.

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Formats

- Format A - The basic size has a span of 2.62 inches (66.55 mm), a thickness of 0.290 inches (7.377 mm), and a total height of 1.95 inches (49.53 mm) including keying pins.
- Format B - The basic size has a span of 2.74 inches (69.59 mm), a thickness of 0.290 inches (7.377 mm), and a total height of 1.95 inches (49.53 mm) including keying pins.
- Format C - The basic size has a span of 5.88 inches (149.35 mm), a thickness of 0.280 inches (7.112 mm), and a total height of 4.06 inches (103.12 mm) including keying pins.
- Format D - The basic size has a span of 5.88 inches (149.35 mm), a thickness of 0.280 inches (7.112 mm), and a total height of 4.83 inches (122.68 mm), including keying pins.
- Format E - The basic size has a span of 5.88 inches (149.35 mm), a thickness of 0.380 inches (9.652 mm), and a total height of 6.68 inches (169.67 mm), including keying pins.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications and standards. The following specification and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-N-290 - Nickel Plating (Electrodeposited).

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification For.
 MIL-C-28754 - Connectors, Electrical, Modular, and Component Parts, General Specification For.
 MIL-M-28787 - Modules, Standard Electronic, General Specification For.
 MIL-M-38510 - Microcircuits, General Specification For.
 MIL-C-39003 - Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification For.
 MIL-G-45204 - Gold Plating, Electrodeposited.
 MIL-P-50884 - Printed-Wiring, Flexible and Rigid-Flex.

STANDARDS

MILITARY

MIL-STD-12 - Abbreviations For Use On Drawings, and In Specifications, Standards and Technical Documents.

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- MIL-STD-130 - Identification Marking of US Military Property
- MIL-STD-242-1 - Electronic Equipment Parts Selected Standards
Synchros, Blowers and Acoustical Parts.
- MIL-STD-242-2 - Electronic Equipment Parts Selected Standards
Crystals, Delay Lines, Coils, and Transformers.
- MIL-STD-242-3 - Electronic Equipment Parts Selected Standards
Resistors.
- MIL-STD-242-4 - Electronic Equipment Parts Selected Standards
Capacitors.
- MIL-STD-242-6 - Electronic Equipment Parts Selected Standards
Relays.
- MIL-STD-242-7 - Electronic Equipment Parts Selected Standards
Switches.
- MIL-STD-275 - Printed-Wiring for Electronic Equipment.
- MIL-STD-701 - Lists of Standard Semiconductor Devices.
- MIL-STD-883 - Test Methods and Procedures for
Microelectronics.
- MIL-STD-889 - Dissimilar Metals.
- MIL-STD-961 - Military Specifications and Associated
Documents, Preparation of.
- MIL-STD-1285 - Marking of Electrical and Electronic Parts.
- MIL-STD-1378 - Requirements for Employing Standard Electronic
Modules.
- MIL-STD-1562 - Lists of Standard Microcircuits.
- MIL-STD-1772 - Certification Requirements for Hybrid
Microcircuit Facilities and Lines.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1 2 Other Government documents. The following other Government documents form a part of this standard to the extent specified herein Unless otherwise specified, the issues are those cited in the solicitation

HANDBOOKS

DEFENSE LOGISTIC AGENCY (DLA)

Cataloging Handbook - Federal Supply Code for Manufacturers
H4-2 (United States and Canada) Code to Name

Cataloging Handbook - Federal Item Name Directory for Supply
H6 Cataloging

(Applications for copies should be addressed to the Defense Logistics Agency, Defense Logistics Service Center, Battle Creek, MI 49016.)

2.2 Order of precedence. In the event of conflict between the text of this document and the references cited herein, (except for related associated detail specifications or 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. DEFINITIONS

3.1 Standard Electronic Modules (SEM) Program. SEM program is a design standardization program which has for its goal the development of functionally specified electronic modules from which a variety of complex military electronic systems may be built.

3.2 SEM Design Review Activity (SEM-DRA). SEM-DRA is the activity responsible for the review and classification of module designs is the Naval Avionics Center, Code 814, 6000 East 21 Street, Indianapolis, IN 46219-2189.

3.3 SEM Quality Assurance Activity (SEM-QAA). SEM-QAA is the activity responsible for specification and design review, correlation, vendor audits, and qualification testing is the Commanding Officer, Naval Weapons Support Center, Code 603, Crane, IN 47522-5060.

3.4 Key code. Key code is an alpha or alpha-numeric (for example, A4A) designator used to identify the style and angular position of the keying pins.

3.5 Alpha end. Alpha end is the end of a module nearest the lowest numbered contact

3.6 Beta end. Beta end is the end of a module farthest from the lowest numbered contact.

3.7 Critical component temperature (CCT). CCT is the maximum junction temperature allowed for any component in the module while the module is operating at maximum class temperature.

3.8 Transient critical component temperature (TCCT). TCCT is the maximum junction temperature allowed for any component in the module while the module is operated at maximum class temperature plus 20 degrees Celsius ($^{\circ}\text{C}$).

3 9 Powered socket. A powered socket is a socket whose terminals are connected to active power supplies, control circuits, loads, and signal sources to simulate system requirements.

3 10 Pitch. Module pitch is the distance between the center lines of the module guide ribs mounted in a card cage adjacent to each other.

4 GENERAL REQUIREMENTS

4.1 Specification and standards Modules shall be in accordance with the requirements of the detail specification, MIL-M-28787, this standard, and MIL-STD-1378. Exceptions and alternates or equivalent materials, parts, processes, documentation, and so forth, shall be approved by the SEM-QAA prior to their use in the design of a module.

4.2 Electrical configuration requirements. Electrical function and contact assignments shall be in accordance with tables I and II. The maximum allowable current for each contact shall be 3 amperes (direct current (dc) or alternating current (ac) root mean square (rms)). When a module is designed in a new logic/technology family that duplicates an existing module function in a different logic/technology family, the new module shall be designed such that the contact assignments on the new module are identical to those of the existing module.

4.2.1 Preassigned dedicated contacts. Contacts with assigned functions which are not marked with an asterisk (* means optional) shall be considered preassigned and dedicated (see tables I and II). Such contacts shall be used for their preassigned function and used in accordance with the rules specified below or left unused.

4.2.2 Optional contact assignment. Contacts with assigned functions marked with an asterisk (*) shall be considered optional contacts (see tables I and II). They shall be used for their preassigned function or in accordance with the rules specified below.

- (a) Functions shall appear on dedicated contacts before they appear on optional or unassigned contacts.
- (b) Functions shall appear on optional contacts before they appear on unassigned contacts.
- (c) Fixed voltages of different potentials shall not be assigned to adjacent contacts.

TABLE I. Contact function (40 contact input/output connector contact assignments).

1. +5 V	21. +5 V*
2.	22.
3. +V dc	23. +V dc*
4.	24.
5.	25.
6.	26.
7.	27.
8.	28.
9.	29.
10. GND	30. GND*
11. Frame GND*	31.
12.	32.
13.	33.
14.	34.
15. Analog GND	35. Analog GND*
16.	36.
17.	37.
18.	38.
19.	39.
20. -V dc	40. -V dc*

* Means optional.

TABLE II Contact function (50-250 contact input/output connector contact assignments).

Row A	Row B	Row C	Row D	Row E
1 +5 V	51. +5 V*	101.	151. +5 V*	201. +5 V
2	52.	102.	152.	202.
3. +V*	53. +V*	103.	153. +V*	203. +V*
4.	54.	104.	154.	204.
5 GND*	55 GND*	105.	155. GND*	205. GND*
6.	56.	106.	156.	206.
7	57	107.	157.	207.
8.	58.	108.	158.	208.
9.	59.	109.	159.	209.
10. GND	60 GND*	110.	160 GND*	210. GND
11. Frame GND*	61.	111.	161.	211.
12.	62.	112.	162.	212.
13	63.	113.	163.	213.
14	64.	114.	164.	214.
15 Analog GND	65. Analog GND*	115.	165. Analog GND*	215. Analog GND*
16.	66.	116.	166	216.
17.	67.	117.	167.	217.
18. +5 V*	68 +5 V*	118.	168. +5 V*	218. +5 V*
19	69.	119.	169.	219.
20 -V dc(1)*	70 -V dc(1)*	120.	170. -V dc(1)*	220. -V dc(1)*
21.	71.	121.	171.	221.
22.	72.	122.	172.	222.
23	73.	123.	173.	223.
24.	74.	124.	174.	224.
25. CONN GND	75. GND*	125.	175. GND*	225. GND
26. (Not appli-	76.	126.	176.	226.
27. cable for	77.	127.	177.	227.
28. molded con-	78.	128.	178.	228.
29 nectors)	79	129.	179	229.
30.	80.	130	180.	230.

* Means optional

TABLE II. Contact function (50-250 contact input/output connector contact assignments) - Continued.

Row A	Row B	Row C	Row D	Row E
31 +5 V*	81. +5 V*	131	181. +5 V*	231. +5 V*
32.	82.	132.	182.	232.
33. +V	83. +V*	133.	183. +V*	233. +V
34.	84.	134.	184.	234.
35. GND	85. GND*	135.	185. GND*	235. GND
36.	86.	136.	186.	236.
37.	87.	137.	187.	237.
38 -V dc(2)	88. -V dc(2)*	138.	188. -V dc(2)*	238. -V dc(2)
39	89.	139.	189.	239.
40. GND	90. GND*	140.	190. GND*	240. GND
41.	91.	141.	191.	241.
42.	92.	142.	192.	242.
43.	93.	143.	193.	243.
44.	94.	144.	194.	244.
45. GND*	95. GND*	145.	195. GND*	245. GND*
46.	96.	146.	196.	246.
47.	97.	147.	197.	247.
48.	98.	148.	198.	248.
49.	99.	149.	199.	249.
50. +5 V*	100. +5 V*	150.	200. +5 V*	250. +5 V*

* Means optional

- (d) Any unused contacts shall be isolated (not connected to any other used or unused contacts).
- (e) Contacts assigned as dedicated or optional contacts may be considered as unassigned only after all the following conditions exist.
 - (1) The contact is not required for the preassigned function.
 - (2) There is a lack of contact availability.
 - (3) All other contact assignment requirements are met.
- (f) Optional contact locations shall be used for nonassigned functions before dedicated contacts are used for nonassigned functions.
- (g) The analog ground shall only be used when two types of grounds are required. These two types of ground contacts shall not be connected together internal to the module. Power ground shall be used if only one type of ground is required.

4.2.3 Connector contact assignments. The use of connector contact assignments of table I and II shall be as follows:

- (a) For a 40 input/output connector use table I.
- (b) For a 100 input/output connector use rows A and B of table II. Contacts are to be numbered consecutively.
- (c) For a 150 contact input/output connector use rows A, B, and E of table II. Contacts are to be numbered consecutively.
- (d) For a 200 contact input/output connector use rows A, B, D, and E of table II. Contacts are to be numbered consecutively.
- (e) For a 250 contact input/output connector use rows A through E of table II

5. DETAILED REQUIREMENTS

5.1 Purpose. This section states the detailed design requirements for SEM.

5.2 Module construction. Modules shall conform to the design, construction, and physical dimensions specified herein and in MIL-M-28787. Modules of a given key code shall be mechanically and electrically interchangeable regardless of the system in which they are used when operated within the module design limits.

5.2.1 Mechanical configuration requirements. The mechanical configurations of modules are specified in appendices A through E.

5.2.1.1 Module depth. Unless otherwise specified in the detail specification, the only parts of the module that extend below the interface plane are the keying pins, contacts, and pin shields. When specified in the detail specification, the body of the module on multiple increment modules is permitted to extend below the interface plane within the limits specified in appendices A through E.

5.2.1.2 Module rib structure. The module ribs shall perform the following functions:

- (a) Alignment during insertion or extraction.
- (b) Retention.
- (c) Cooling.

The rib configuration is shown in appendices A through E.

5.2.1.2.1 Rib strength. Individual module ribs shall withstand a torque of 10 inch-pounds (1.1 newton-meters) minimum maintained for 10 to 15 seconds.

5.2.1.3 Pin shields. Modules shall be provided with pin shields to protect the contacts. Details of the pin shields are specified in appendices A through E. Modules are required to have pin shields adjacent to each outside row of module contacts. Pin shields shall be of a nonconducting material or if of a conducting material, the outside surface of the shield shall be treated in a manner that will prevent conduction into the base conducting material.

5.2.1.3.1 Pin shield retention. The pin shield shall withstand a force of 4 pounds (18 newtons) minimum maintained for 10 to 15 seconds.

5.2.1.4 Module fin and header structure. The module fin for formats A and B and the header structure for formats C, D, and E shall be as specified in appendices A through E.

5.2.1.5 Module connector. The module connector shall be as specified in appendices A through E for the applicable format. Connectors shall be in accordance with MIL-C-28754 and the requirements specified herein. Multiple increment modules may increase contact row quantities with each row of contacts complete.

5.2.1.5.1 Module contacts. The number of contacts on the module and their location shall be as specified herein. The contact configuration is controlled, (see figure 1), only on that part of the contact protruding from the module connector surface (the interface plane).

5.2.1.5.2 Connector contact integrity. Each contact, as mounted in the connector, shall withstand an axial force of 20 ounces (5.6 newtons) minimum applied in 2 to 10 seconds along the length of the contact blade in either direction and maintained for 10 to 15 seconds.

5.2.1.5.3 Contact material. The material used for the module contacts shall be a solid metal selected according to the manufacturing process used. Approved materials are those specified in MIL-C-28754.

5.2.1.5.4 Contact plating. The contacts shall be gold plated in accordance with MIL-G-45204, type II, grade C, class 1. Contacts shall have nickel underplating of 0.00005 inch (0.00127 millimeters (mm)) minimum in accordance with QQ-N-290, class 1.

5.2.1.6 Module keying. Each module is assigned an alpha or alphanumeric key code. The first letter indicates the style and angular position of the keying pin in the alpha keying pin location and the last letter designates the style and angular position of the keying pin in the beta location.

5.2.1.6.1 Keying pin orientation. Keying pins shall be orientated to agree with the basic angle specified for the module by the code letters on figures 2, 3 or 4. The code letters indicate the only possible first and last letters, in that order, of the module keycode for the combination of keying pin styles indicated in that particular figure. Code letter combinations other than those shown entirely within figure 2, 3, or 4 are not allowed. Module keying pin styles and orientations shall be taken entirely from either figure 2, figure 3, or figure 4 - no other combinations (such as mixing an alpha orientation from figure 2 and a beta orientation from figure 3) are allowed. Figure 5 illustrates the module axis and specifies the tolerance for angular positioning.

5.2.1.6.2 Keying pin locations. There are two keying pin locations on each module, one designated alpha and one designated beta. The alpha and beta keying pin locations are near the lowest and highest numbered connector contacts in the first row, respectively, as illustrated on figure 5.

5.2.1.6.3 Keying pin styles. Keying pin styles shall be as specified on figure 6.

5.2.1.6.4 Keying pin sets. Only the keying pin styles and keying pin locations specified in table III are permitted.

TABLE III Keying pin styles and locations.

Location		Style of	Notes
Alpha (α)	Beta (β)	Combination	
Style 1	Style 2	Style 1/2	See figure 2
Style 1	Style 1	Style 1/1	See figure 3
Style 2	Style 2	Style 2/2	See figure 4

5.2.1.6.5 Keying pin integrity requirement. When installed in the module, the keying pins shall meet the following integrity requirements.

5.2.1.6.5.1 Keying pin torque. Each keying pin shall withstand a torque of 20 inch-ounces (0.14 newton-meter) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

5.2.1.6.5.2 Keying pin pullout. Each keying pin shall withstand a pullout force of 9 pounds (40 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

5.2.1.6.5.3 Keying pin cantilever load. Each keying pin shall withstand a cantilever load of 10 pounds (44 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

5.2.2 Printed-wiring and printed-wiring assemblies. Printed-wiring and printed-wiring assemblies shall conform to the following requirements.

5.2.2.1 Rigid printed-boards. The design of rigid printed-boards shall conform to the requirements specified in MIL-STD-275. Equivalent materials, processes, and requirements shall be utilized only when approved by the SEM-QAA. These equivalent materials, processes, and requirements shall be documented and forwarded to the SEM-QAA for review and approval.

5.2.2.2 Printed-board assemblies. The design of printed-board assemblies shall conform to the requirements specified in appendix H. Equivalent materials, processes, and requirements shall be utilized only when approved by the SEM-QAA. These equivalent materials, processes, and requirements shall be documented and forwarded to the SEM-QAA for review and approval.

5.2.2.3 Flexible printed-board and assemblies. Flexible printed-board and assemblies shall conform to the requirements of MIL-P-50884, type 1, class B.

5.2.3 Materials. Materials used to manufacture modules shall conform to the requirements specified herein and shall be certified in accordance with applicable specifications where required. When a material is not specified, a material shall be used which will enable the module to satisfy the requirements specified herein. Acceptance or approval of a constituent material shall not be construed as an assurance of the acceptance of the finished product.

5.2.3.1 Use of toxic material. Materials which produce dangerous gasses or other harmful toxic effects over the temperature range of minus 55 to plus 125°C, or while burning, are prohibited.

5.2.3.2 Use of flammable material. Materials used in modules shall not support flames or an explosive-type fire and shall be self extinguishing within 5 seconds after removal of a propane flame.

5.2.3.3 Use of material affected by fungus. Materials used in modules shall allow no more than trace amounts of fungal growth.

5.2.3.4 Use of adhesive backed labels. Adhesive backed labels shall be as permanent as the normal life expectancy of the item to be marked and shall meet the solvents requirements of MIL-M-28787. Labeling shall be in a manner which will not adversely affect the function and reliability of the items.

5.2.4 Finishes and protective treatments. The finishes and protective treatment of surfaces shall enable the module to meet the requirements specified herein. Acceptance or approval of a finish or protective treatment shall not be construed as an assurance of the acceptance of the finished product. MIL-STD-889 shall be used in the selection of finishes and protective treatments to insure galvanic corrosion protection.

5.2.4.1 Anodic treatment/frame plating. Frame surface treatments shall be as specified in appendices A through E.

5.2.4.2 Module frame surface finish. The surface finish of the module frame shall be as specified in appendices A through E.

5.2.4.3 Conformal coating The conformal coating shall be in accordance with the requirements of appendix H. The conformal coating shall be a continuous, homogeneous, fully cured material which covers all components, leads, and circuitry, except grounding surfaces. The coating thickness may vary with the irregularity of the module surface.

5.2.5 Weight. Modules shall be designed for minimum weight consistent with the requirements stated herein and in the detailed module specification.

5.3 Environmental requirements. Modules shall be designed to withstand the following environmental conditions. See MIL-M-28787 for details of tests to confirm these design requirements.

5.3.1 Operating environmental requirements. Modules shall withstand the following operating requirements.

5.3.1.1 Operating temperature. The modules shall withstand the following conditions.

- (a) Low temperature. Classes I and III shall withstand 0°C (plus 0, minus 10°C). Classes II and IV shall withstand minus 55°C (plus 0, minus 10°C)

- (b) High temperature. Classes I and III shall withstand 60°C (plus 10, minus 0°C). Classes II and IV shall withstand 85°C (plus 10, minus 0°C).
- (c) Transient temperature. Classes I and III shall withstand a transient temperature of 80°C (plus 10, minus 0°C). Classes II and IV shall withstand a transient temperature of 105°C (plus 10, minus 0°C).

5.3.1.2 Vibration. Classes I and III modules shall withstand a simple harmonic motion, amplitude 0.03 inch (0.76 mm), between 10 and 55 hertz (Hz) and a random vibration, power spectral density 0.1 gravity (g) square/Hz, of 11.6 g rms. Classes II and IV modules shall withstand a simple harmonic motion, 0.06 inch (1.52 mm) double amplitude or 30 g (whichever is less) at frequency range of 10 to 2000 Hz for at least two hours. Classes II and IV modules shall withstand a random vibration, power spectral density 0.2 g squared/Hz, of 16.4 g.

5.3.1.3 Inclination. Modules shall withstand inclination at the rate of 5 to 7 cycles per minute in all vertical planes to angle of 90 degrees from all vertical planes.

5.3.1.4 Life. Modules shall be operated for at least 500 hours with module thermal interface held at the maximum class operating temperature and still meet end-of-life limits as specified in that module's detail specification.

5.3.1.5 Pressure. Classes II and IV modules shall withstand a reduced barometric pressure of 8.00 millimeters of mercury.

5.3.1.6 Radiation. Classes III and IV modules shall withstand an ionizing dose rate of 1×10^9 rad (Silicon (Si))/s, a total ionizing dose of 3×10^3 rad (Si), and a neutron fluence (flux) of 2×10^{12} neutrons per cm squared.

5.3.2 Nonoperating environmental requirements. Modules shall withstand the following nonoperating requirements.

5.3.2.1 Humidity Modules shall withstand humid atmosphere cycles of 65°C at 95 percent relative humidity and 30°C at 85 percent relative humidity

5.3.2.2 Thermal shock. Classes I and III shall withstand a thermal shock of minus 55 to 85°C. Classes II and IV shall withstand a thermal shock of minus 55 to 125°C.

5.3.2.3 Shock Modules shall withstand a shock of 100 g's acceleration peak value, normal duration of 6 milliseconds, and a velocity change of 12.3 feet per second.

5.3.2.4 Salt fog. Modules shall withstand a salt fog atmosphere from a 5 percent salt solution at 35°C for 48 hours.

5.3.2.5 Hydrogen atmosphere. Modules with metal oxide thick film resistors shall withstand a 10 percent hydrogen, 90 percent nitrogen atmosphere for a minimum of 6 hours.

5.3.2.6 Storage temperature. Modules shall withstand storage temperature in the range of minus 55 to 125°C.

5.4 Module marking. Modules shall be identified and marked with appropriate identifiers as specified herein. Appendices A through E specify the marking areas for the following information:

- (a) Module key code.
- (b) Module part number, revision letter and amendment number.
- (c) Certification mark
- (d) Module name.
- (e) Vendor's information.
 - (1) Vendor's identification
 - (2) Serial number.

- (3) Date code
- (f) Connector contact identification.
- (g) Electrostatic discharge (ESD) marking.
- (h) RAM/ROM test code.
- (i) Extractor fin identification.

Markings excluding key code shall be a minimum of 0.06 inch (1.52 mm) high and shall be located as specified in appendices A through E and applied in accordance with MIL-STD-130. Informational elements (key code, serial number, and so forth) shall be marked in a single line on the module fin (or test header) and shall be appropriately spaced from each other. Marking shall be in a contrasting color to the surrounding module area. Marking shall be permanent and legible in accordance with MIL-STD-1285.

5.4.1 Module key code. The key code assigned to each module shall be marked as specified in appendices A through E. The marking is located at the alpha end of the module on the top surface of the identification fin/header. For modules that have firmware (programmable integrated circuits), the key code may include a dash number. This dash number is the ROM/PROM program code, and it designates the programmed version.

5.4.2 Module part number, revision letter, and amendment number. The module part number, revision letter, and amendment number shall be marked as specified in appendices A through E. This information is located in the same area as the vendor's information. All standard module part numbers will be assigned by the SEM-DRA. Requests for part number assignment shall be prepared and submitted in accordance with MIL-STD-1378. Modules documented in accordance with MIL-STD-961 shall be marked with the appropriate revision of the specification to which the modules were tested. This marking shall be in the following sequence:

5.4.4 Module name. Each module shall have its name marked in the area specified in appendices A through E. The name and vendor's information shall be oriented such that both are readable from the same point of view. The name marked on the module shall agree with the name in the title of the detail specification; however, abbreviation in accordance with MIL-STD-12 is permissible. The SEM-DRA is responsible for generation of an approved name. The names in Handbook H6 shall be used if they appropriately describe the module. When Handbook H6 does not list a name which appropriately describes the module, a name shall be developed in accordance with MIL-STD-961.

5.4.5 Vendor's information. The following information shall be marked on each module at the locations specified in appendices A through E. No other module vendor's part number shall be marked on the module.

5.4.5.1 Vendor's identification. Each module shall be marked with either the vendor's identification code or vendor's name. The vendor's code, if utilized, shall be a numerical code as listed in Handbook H4-2. A test code for each vendor's integrated circuit type used shall be marked on each Random Access Memory/Read Only Memory (RAM/ROM) module in the area specified for a vendor's identification.

5.4.5.2 Serial number. Each module shall have a serial number including vendor's designation as specified in appendices A through E. The serial number is located on the top surface of the same fin/header used for marking the key code. The serial number shall consist of five digits with significant digits prefixed with zeros, as required. The serial number shall be affixed to the module prior to electrical acceptance tests.

5.4.5.2.1 Serial number sequence. Each module manufacturer shall serialize each module manufactured under the requirements of SEM. The serial number for any given key code will start with number one (1) and continue in numerical sequence as many times as the module is manufactured regardless of contract or customer. When the serial number 99999 is reached, the next module serial number shall be 00001. Date code identification shall distinguish between duplicate serial numbers

5.4.5.2.2 Vendor designation. A single or double alpha character shall be assigned to each module manufacturer contracted to produce modules. The designation shall be prefixed to the module serial number as specified in appendices A through E. Request for a vendor designation shall be submitted to the SEM-DRA (see 3.2).

5.4.5.3 Date code. Each module shall be marked with a four digit date code designating the year and the week of manufacture. The first two digits of the code shall be the last two numbers of the year and the third and fourth digits of the code shall be the calendar week. When the number of the week is a single digit, it shall be preceded by a zero. The date code for a given module shall be the calendar week in which the last major manufacturing assembly process occurred prior to the final acceptance inspection, plus or minus one week.

5.4.6 Connector contact identification. Each connector shall have contacts identified by numbers on the connector pin shield as indicated herein (see figure 5) or in the individual slash sheets of MIL-C-28754.

5.4.7 ESD. Modules that contain one or more part types listed in table IV as approved by the SEM-QAA shall be marked in area specified in appendices A through E with the sensitive electronic device symbol specified in MIL-STD-1285.

5.4.8 RAM/ROM test code. Modules utilizing solid-state memory devices shall be assigned a RAM/ROM test code by the module vendor which identifies the revision level of the test vector set used during functional testing of the module. The test code marking shall consist of a three digit code and shall be assigned sequentially beginning with 001. The test code marking shall be located as shown herein. Module vendors shall maintain an archive file containing sufficient information to ensure that the test vector set may be regenerated for any previously used test code. Copies of the test vector sets for any test code shall be made available to the SEM-QAA upon request. (The RAM/ROM test code should not be confused with the ROM/PROM program code. The ROM/PROM program code is assigned by the SEM-DRA and is part of the module key code, not a separate number)

TABLE IV. Part constituents susceptible to ESD

Part constituent	Part type
MOS structures	MOS FET (discretes) MOS ICs Semiconductors with metalization cross-overs Digital ICs (bipolar and MOS) Linear ICs (bipolar and MOS) MOS capacitors Hybrids Linear ICs
Semiconductor junctions	Diodes (PN, PIN, Schottky) Transistors, bipolar Junction field effect transistors Thyristors Bipolar ICs, digital and linear Input protection circuits on: Discrete MOS FETs MOS ICs

TABLE IV Part constituents susceptible to ESD - Continued.

Part constituent	Part type
Film resistors	Hybrid ICs: Thick film resistors Thin film resistors Monolithic IC-thin film resistors Encapsulated film resistors
Metallization strips	Hybrid ICs Monolithic ICs Multiple finger overlay transistors
Field effect structures and nonconductive lids	LSI and memory ICs employing nonconductive quartz or ceramic package lids especially ultraviolet EPROMS
Piezoelectric crystals	Crystal oscillators Surface acoustic wave devices
Closely spaced electrodes	Surface acoustic wave devices Thin metal unpassivated, unprotected semiconductors and microcircuits

5.4.9 Extractor fin identification. Modules of formats A and B are permitted multiple thicknesses. Multiple fins aid in the extraction of these modules. Such fins must be marked. See appendix A and appendix B.

5.5 Module design requirements. Modules shall be designed in accordance with the following requirements.

5.5.1 Personnel safety. Modules with voltage potentials exceeding 30 volts (dc or ac rms) to ground shall have exposed conductive frame surfaces (except for pin shields and key pins) connected to either the 0 volt or frame ground contact. The maximum resistance between the ground contact and exposed conductive frame surfaces shall be 1 ohm.

5.5.2 Powered socket. The detail specification for modules containing device technologies which cannot be protected by the module design during removal or insertion into a powered socket must contain caution notices of susceptibility to damage.

5.5.3 Component selection. Electronic components and hardware used in modules shall have a demonstrated quality level and environmental performance equivalent to or better than that of available military QPL parts. Nonhermetically sealed packaged relays and semiconductor devices having hermetically sealed equivalents shall not be used.

5.5.3.1 Germanium semiconductors. Germanium semiconductors shall not be used.

5.5.3.2 Discrete semiconductors. Discrete semiconductors shall be in accordance with the requirements of MIL-S-19500 and shall be selected according to the following priority list. Devices listed in b, c, and d shall be approved by the SEM-QAA prior to use.

- (a) MIL-S-19500 JANTX devices listed in MIL-STD-701.
- (b) Other MIL-S-19500 JANTX devices.
- (c) Devices being considered for a MIL-S-19500 JANTX detail specification. Devices shall be equal to or better than MIL-S-19500 JANTX devices.

- (d) Other devices Devices shall be equal to or better than MIL-S-19500 JANTX devices.

5 5 3 3 Integrated circuits. Integrated circuits shall be in accordance with the following requirements.

5.5.3.3.1 Quality requirements. Integrated circuits shall be in accordance with the requirements of MIL-M-38510, class B. The module vendor shall use MIL-M-38510 JAN QPL devices when available or acquire other devices with equivalent specifications. Equivalent specifications shall be submitted to the SEM-QAA for approval prior to initial qualification. Equivalent specifications shall include:

- (a) The screening shall be to MIL-STD-883, method 5004.9, class B.
- (b) Quality conformance shall be demonstrated in accordance with MIL-STD-883, method 5005.11, groups A, B, C, D, and E (if applicable), class B.
- (c) Generic data is acceptable for demonstrating quality conformance in accordance with MIL-STD-883, method 5005, groups C and D, class B. A generic family shall be electrically and structurally similar integrated circuits. They are designed to perform the same type of basic circuit function using the same basic circuit element configuration and differ only in the number of identically specified circuits which they contain. They are designed for the same supply, bias, and signal voltages and for input-output compatibility with each other under an established set of loading rules. They are enclosed in packages of the same construction and outline, differing only in the number of active external package leads included or used and made from the same materials by use of the same processes.

5 5.3.3.2 Selection requirements. Integrated circuits shall be in accordance with the requirements of MIL-M-38510 and shall be selected according to the following priority list. Devices listed in b, c, d and e shall be approved by the SEM-QAA prior to use.

- (a) MIL-M-38510 JAN microcircuits listed in the table of preferred devices in MIL-STD-1562.
- (b) Other MIL-M-38510 microcircuits not listed in the tables of logistics or continuous replacements, inactive or suspended military activity, or not recommended under any circumstances in MIL-STD-1562.
- (c) Other microcircuits listed in the table of potential standardization candidates in MIL-STD-1562 as preferred for new designs.
- (d) DESC/standard military drawing (SMD) microcircuits not listed in the tables of logistics or continuous replacements, inactive or suspended military activity, or not recommended under any circumstances in MIL-STD-1562.
- (e) Other microcircuits (see 5.5.3.5).

5.5.3.3.3 Restricted usage. Memory devices that are addressed or programmed in parallel with other devices on the module shall be selected and used such that all devices have the same addressing and programming characteristics on an individual module.

5.5.3.4 Passive components. Passive components shall be selected according to the following priority list. Devices listed in (c) and (d) shall be approved by the SEM-QAA prior to use.

- (a) Established reliability (ER) specification parts (minimum level R if multiple sources exist) listed in MIL-STD-242-1, MIL-STD-242-2, MIL-STD-242-3, MIL-STD-242-4, MIL-STD-242-6, and MIL-STD-242-7. If multiple sources of level R parts do not exist, level P parts may be used to achieve multiple sources.
- (b) ER parts (minimum level M if required to achieve multiple sourcing) listed in MIL-STD-242-1 through MIL-STD-242-4, MIL-STD-242-6, and MIL-STD-242-7
- (c) Other ER parts.

- (d) Conventional military specification parts.
- (e) ER parts that use the Weibull failure rate prediction method, as specified in MIL-C-39003, shall require a B minimum failure rate level.
- (f) Use of carbon composition resistors is prohibited.

5.5.3.5 Other microcircuits. All other microcircuits shall include the following information in the non-standard part specification.

- (a) Device nomenclature, marking, configuration, Group A electrical requirements for the full military temperature range which will insure form, fit, function, and interchangeability.
- (b) The required sampling and screening plans which will allow the procured devices to meet, as a minimum, all requirements of MIL-STD-883, specifying the use of MIL-STD-883 in conjunction with non-JAN devices. Hybrids shall meet the requirements of MIL-M-38510, appendix G, for a class B product assurance level.
- (c) Hybrid microcircuit suppliers of SEM shall be certified to MIL-STD-1772 or in the process of receiving MIL-STD-1772 certification and certified by SEM-QAA.

5.5.4 Reliability design goals. Modules shall be designed for the following Mean Time Between Failure (MTBF) values at maximum temperature for the appropriate class. Formats A and B shall be designed for a minimum MTBF of 100,000 hours. Formats C, D, and E shall be designed for a minimum MTBF of 50,000 hours.

5.5.5 Parts derating, thermal performance, and failure rate prediction. The module parts derating, thermal performance, and failure rate prediction shall be performed in accordance with appendix G

5.5.6 Diagnostic design requirements. All modules shall be designed such that automated component fault isolation techniques (for instance, guided probe or fault dictionary) can isolate failures to within: one component not less than 95 percent of the time; two components not less than 98 percent of the time, and four components not less than 100 percent of the time. All module input pin, output pin, and component pin faults shall be considered in grading fault isolation.

6. NOTES

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

6.1 Intended use. This standard contains design requirements for the design of standard electronic modules for use in military systems.

6.2 Issue of DODISS. When this standard is used in acquisition, the issue of the DODISS to be applicable to this solicitation must be cited in this solicitation (see 2.1.1).

6.3 Supersession data. This standard supercedes the requirements of MIL-STD-1389C dated 16 May 1986 and Naval Sea Systems Command Drawing No. 6133410 dated 7 April 1987.

6.4 Subject term (keyword) listing.

Modules, Standard Electronic
SEM
Standard Electronic Modules
Standard Electronic Modules Program

6.5 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.

Custodians:

Army - ER
Navy - SH
Air Force - 85

Preparing activity:

Navy - SH

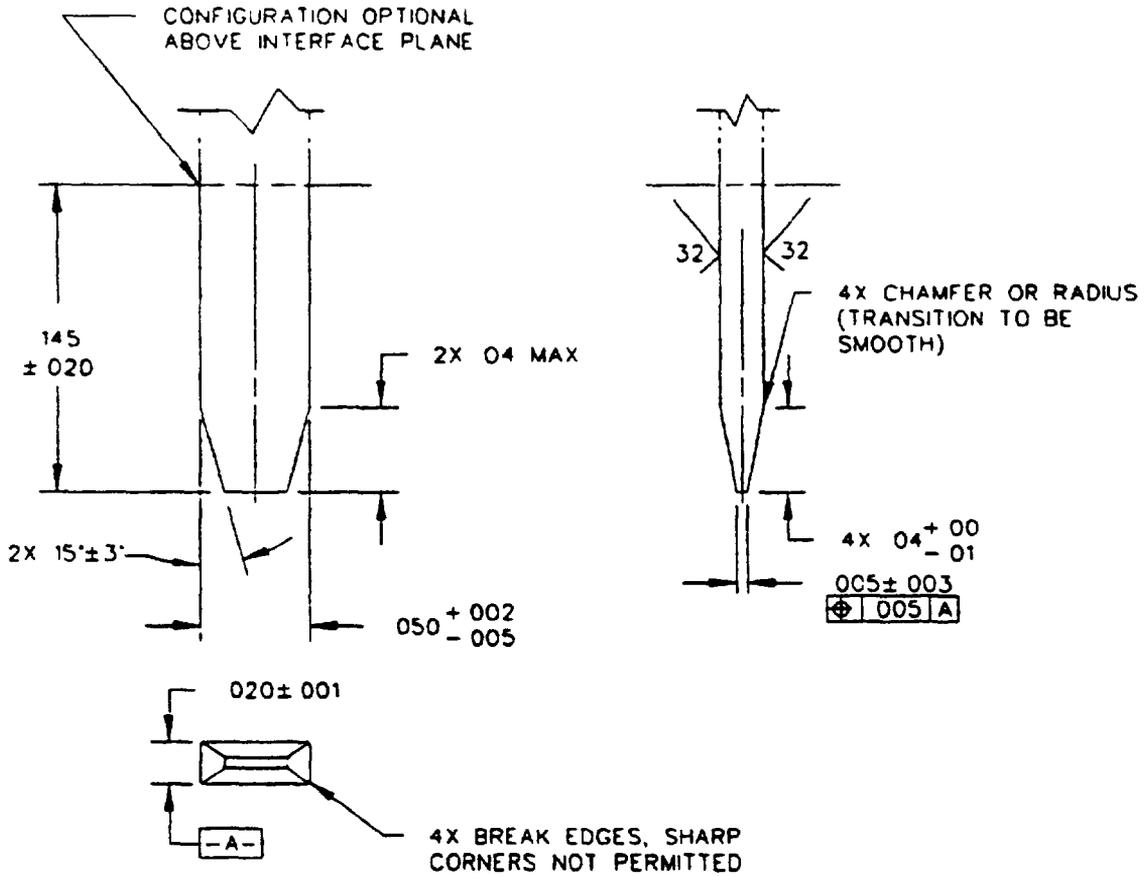
Agent:

NWSC Crane

Review activities:

Army - AT, AV
Navy - AS, MC, SH
Air Force - 13, 17, 19
DLA - ES

(Project 5963-0040)



Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.001	0.025	0.005	0.127	0.020	0.508	0.050	1.270
0.002	0.051	0.01	0.25	0.04	1.02	0.145	3.683
0.003	0.076						

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 1. Module blade contact.

BETA LOCATION ALPHA	A,J 0°	B,K 45°	C,L 90°	D,M 135°	E,N 180°	F,P 225°	G,Q 270°	H,R 315°
	A-A A-J J-A J-J	B-B A-K J-B J-K	A-C A-L J-C J-L	A-D A-M J-D J-M	A-E A-N J-E J-N	A-F A-P J-F J-P	A-G A-Q J-G J-Q	A-H A-R J-H J-R
	B-A B-J K-A K-J	B-B B-K K-B K-K	B-C B-L K-C K-L	B-D B-M K-D K-M	B-E B-N K-E K-N	B-F B-P K-F K-P	B-G B-Q K-G K-Q	B-H B-R K-H K-P
	C-A C-J L-A L-J	C-B C-K L-B L-K	C-C C-L L-C L-L	C-D C-M L-D L-M	C-E C-N L-E L-N	C-F C-P L-F L-P	C-G C-Q L-G L-Q	C-H C-R L-H L-R
	D-A D-J M-A M-J	D-B D-K M-B M-K	D-C D-L M-C M-L	D-D D-M M-D M-M	D-E D-N M-E M-N	D-F D-P M-F M-P	D-G D-Q M-G M-Q	D-H D-R M-H M-R
	E-A E-J N-A N-J	E-B E-K N-B N-K	E-C E-L N-C N-L	E-D E-M N-D N-M	E-E E-N N-E N-N	E-F E-P N-F N-P	E-G E-Q N-G N-Q	E-H E-R N-H N-R
	F-A F-J P-A P-J	F-B F-K P-B P-K	F-C F-L P-C P-L	F-D F-M P-D P-M	F-E F-N P-E P-N	F-F F-P P-F P-P	F-G F-Q P-G P-Q	F-H F-R P-H P-R
	G-A G-J Q-A Q-J	G-B G-K Q-B Q-K	G-C G-L Q-C Q-L	G-D G-M Q-D Q-M	G-E G-N Q-E Q-N	G-F G-P Q-F Q-P	G-G G-Q Q-G Q-Q	G-H G-R Q-H Q-P
	H-A H-J R-A R-J	H-B H-K R-B R-K	H-C H-L R-C R-L	H-D H-M R-D R-M	H-E H-N R-E R-N	H-F H-P R-F R-P	H-G H-Q R-G R-Q	H-H H-R R-H R-R

FIGURE 2. Style 1/2 keying chart (viewing connector as shown on figure 5).

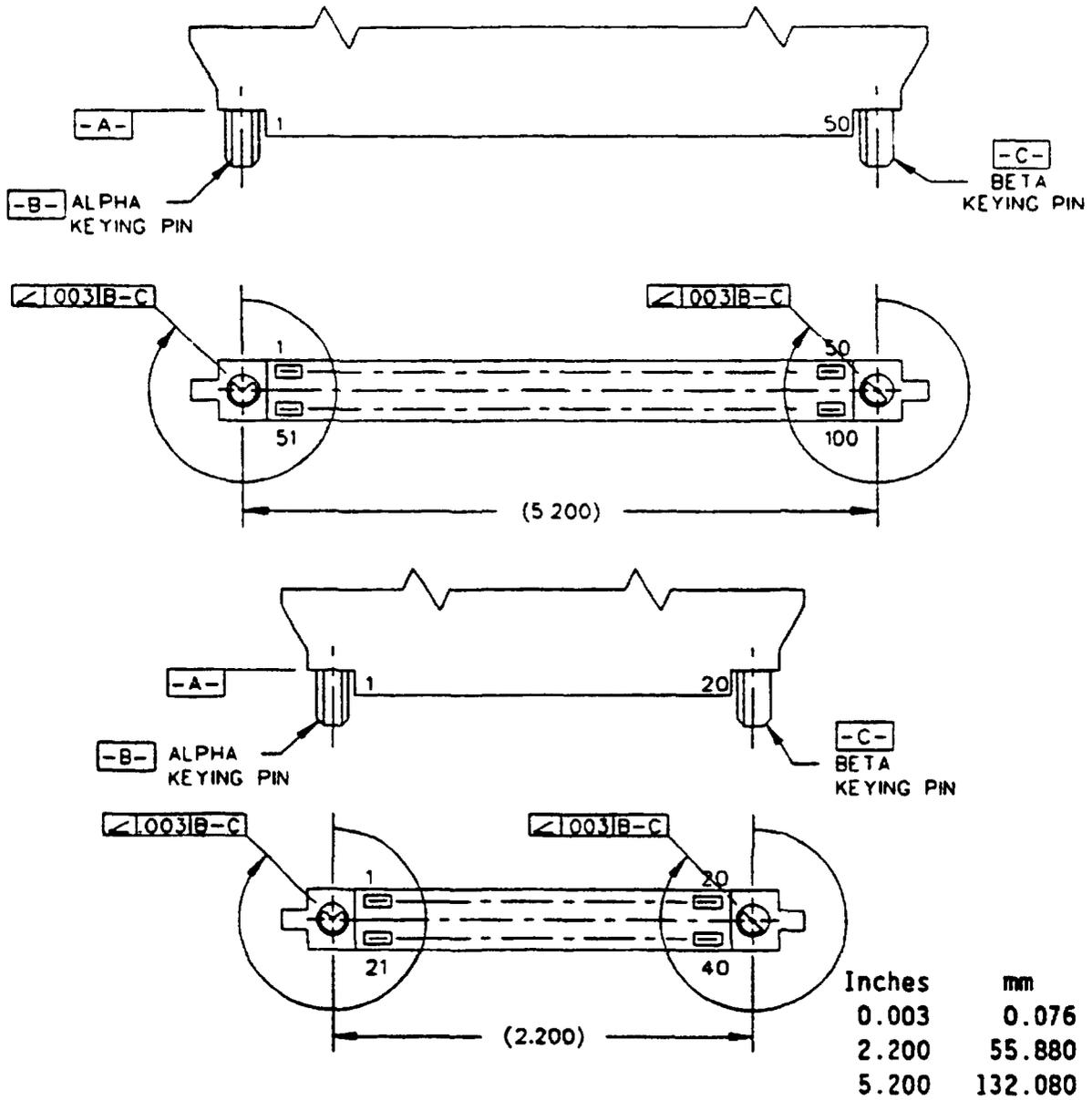
MIL-STD-1389D

BETA LOCATION ALPHA	S 0°	T 45°	U 90°	V 135°	W 180°	X 225°	Y 270°	Z 315°
S 0°								
T 45°	T-S	T-T	T-U	T-V	T-W		T-Y	T-Z
U 90°	U-S	U-T	U-U	U-V	U-W			U-Z
V 135°	V-S	V-T	V-U	V-V	V-W			
W 180°		W-T	W-U	W-V	W-W			
X 225°			X-U	X-V	X-W			
Y 270°				Y-V	Y-W			
Z 315°					Z-W			

FIGURE 3. Style 1/1 keying chart (viewing connector as shown on figure 5).

BETA LOCATION ALPHA	S 0°	T 45°	U 90°	V 135°	W 180°	X 225°	Y 270°	Z 315°
S 0°	S-S	S-T	S-U	S-V		S-X	S-Y	S-Z
T 45°								
U 90°						U-X		
V 135°						V-X	V-Y	
W 180°						W-X	W-Y	W-Z
X 225°	X-S					X-X	X-Y	X-Z
Y 270°	Y-S	Y-T				Y-X	Y-Y	Y-Z
Z 315°	Z-S	Z-T	Z-U			Z-X	Z-Y	Z-Z

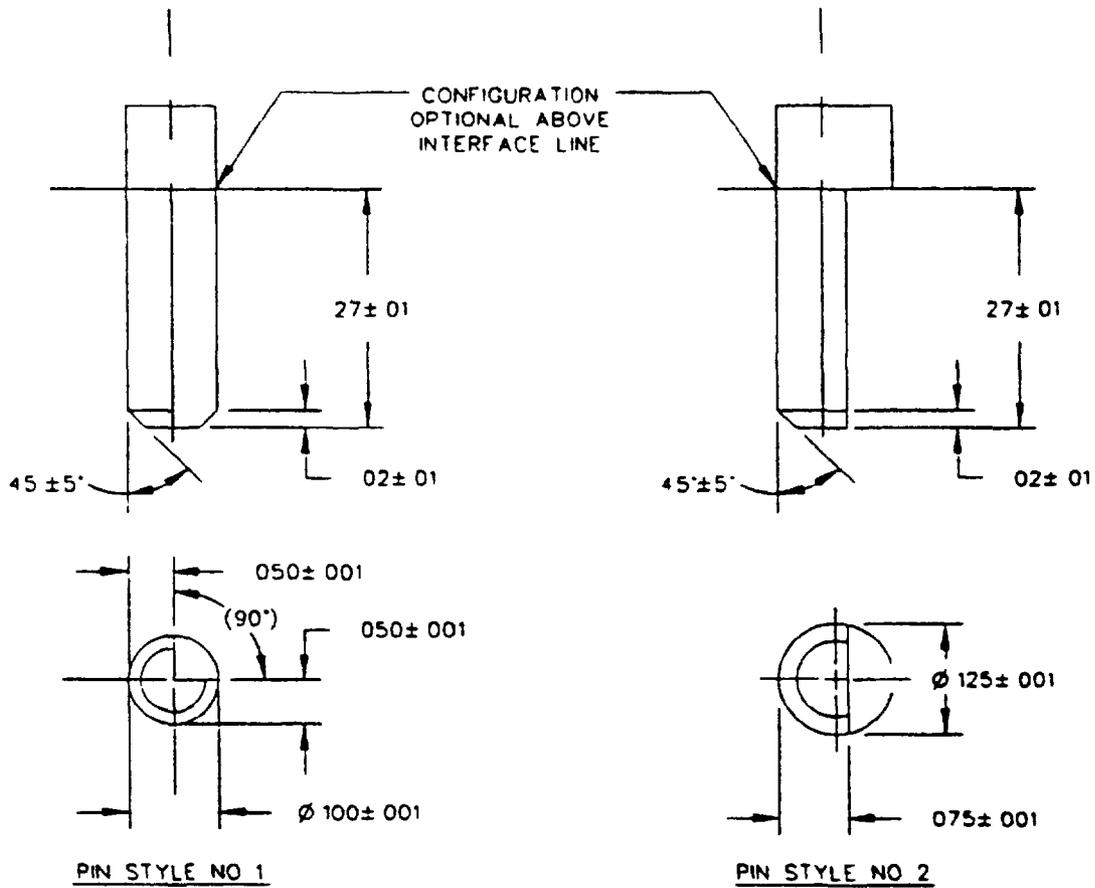
FIGURE 4. Style 2/2 keying chart (viewing connector as shown on figure 5)



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only

FIGURE 5. Keying pin orientation.



Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.001	0.025	0.02	0.51	0.075	1.905	0.125	3.175
0.01	0.25	0.050	1.270	0.100	2.540	0.27	6.86

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 6. Module keying pin styles.

APPENDIX A

DESIGN REQUIREMENTS FOR FORMAT A MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of the standard for the design requirements for format A modules to be used in SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standards. The following specification and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-A-8625 - Anodic Coatings, For Aluminum and Aluminum Alloys.

STANDARDS

FEDERAL

FED-STD-595 - Colors.

MILITARY

DOD-STD-100 - Engineering Drawing Practices.

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(Unless otherwise indicated, copies of the federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Ave, Philadelphia, PA 19120-5099.)

30. GENERAL REQUIREMENTS

30.1 Mechanical configuration requirements. The basic mechanical configurations for format A are the single-span, single-thickness module specified on figures 7 and 8 and in table V. Drawing practices shall be in accordance with DOD-STD-100.

30.2 Thermal requirements. Modules shall be designed to be cooled through the fin or ribs and shall be capable of being cooled by either method with no other heat loss.

40. DETAILED REQUIREMENTS

40.1 Configuration. The basic size module has a span of 2.62 inches (66.55 mm), a thickness of 0.290 inches (7.366 mm), and is 1.95 inches (49.53 mm) high including keying pins. The module may increase in span, thickness, or simultaneously in both span and thickness. For multiple increment modules, span shall be increased in 3.000 inch (76.200 mm) increments and thickness shall be increased in 0.300 inch (7.620 mm) increments as specified in table V. Module configurations and size designations shall conform to the span and thickness matrix of table V. Dimensions and tolerances shall be as specified on figures 8 and 9. Plate mounted modules shall be as specified on figure 10 and sub-plate mounted modules shall be as specified on figure 11.

40.1.1 Circuitry. External circuitry and components shall be contained within an area defined by the following: a minimum of 0.050 inch (1.270 mm) inward on each side from two vertical parallel lines established by the CC dimension and a maximum of 1.286 inches (32.664 mm) measured vertically from the interface plane (see figure 8)

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TABLE V. Module span and thickness increments. 1/ 2/

Span <u>3/</u> 3.00 in. (76.20 mm) increments	Thickness in inches (mm) <u>4/</u>						
Span design	A 0.290 (7.366)	B 0.590 (14.986)	C 0.890 (22.606)	D 1.190 (30.226)	E 1.490 (37.846)	F 1.790 (45.466)	G 2.090 (53.086)
1	1A	1B	1C	1D	1E	1F	1G
2	2A	2B	2C	2D	2E	2F	2G
3	3A	3B	3C	3D	3E	3F	3G

H 2.390 (60.706)	J 2.690 (68.326)	K 2.990 (75.946)	L 3.290 (83.566)	M 3.590 (91.186)	N 3.890 (98.806)	P 4.190 (106.426)	R 4.490 (114.046)
1H	1J	1K	1L	1M	1N	1P	1R
2H	2J	2K	2L	2M	2N	2P	2R
3H	3J	3K	3L	3M	3N	3P	3R

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TABLE V Module span and thickness increments. - Continued. 1/ 2/

S 4.790 (121.666)	T 5.090 (129.266)	U 5.390 (136.906)	V 5.690 (144.526)	W 5.990 (152.146)	Y 6.290 (159.766)	Z 6.590 (167.366)
1S	1T	1U	1V	1W	1Y	1Z
2S	2T	2U	2V	2W	2Y	2Z
3S	3T	3U	3V	3W	3Y	3Z

- 1/ Dimensions are in inches.
- 2/ Metric equivalents are given for general information only.
- 3/ Span is measured across the ribs.
- 4/ Each letter is 0.300 inch (7.620 mm) greater than the previous letter with "A" equal to 0.290 inch (7.366 mm) maximum.

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TABLE VI. Module span and thickness dimensions (see figures 8 and 9 for details). 1/ 2/

Span	Dimensions				
	AA ±0.01 (0.25)	BB ±0.01 (0.25)	CC +0.005 (0.127) -0.075 (1.905)	DD basic	EE ±0.01 (0.25)
1	2.32 (58.93)	1.89 (48.01)	2.440 (61.976)	2.200 (55.880)	2.62 (66.55)
2	5.32 (135.13)	4.89 (124.21)	5.440 (138.176)	5.200 (132.080)	5.62 (142.75)
3	8.32 (211.33)	7.89 (200.41)	8.440 (214.376)	8.200 (208.280)	8.62 (218.95)

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
A	0.290 (7.366)	0.220 (5.588)	0
B	0.590 (14.986)	0.520 (13.208)	0.300 (7.620)
C	0.890 (22.606)	0.820 (20.828)	0.600 (15.240)
D	1.190 (30.226)	1.120 (28.448)	0.900 (22.860)

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
E	1.490 (37.846)	1.420 (36.068)	1.200 (30.480)
F	1.790 (45.466)	1.720 (43.686)	1.500 (38.100)
G	2.090 (53.086)	2.020 (51.306)	1.800 (45.720)
H	2.390 (60.706)	2.320 (58.926)	2.100 (53.340)

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TABLE VI Module span and thickness dimensions (see figures 8 and 9 for details) - Continued. 1/ 2/

Thick- ness letter	Dimensions			Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic		GG maximum	HH minimum	JJ basic
J	2.690 (68.326)	2.620 (66.548)	2.400 (60.960)	S	4.790 (121.666)	4.720 (119.888)	4.500 (114.300)
K	2.990 (75.946)	2.920 (74.168)	2.700 (68.580)	T	5.090 (129.286)	5.020 (127.508)	4.800 (121.920)
L	3.290 (83.566)	3.220 (81.788)	3.000 (76.200)	U	5.390 (136.906)	5.320 (135.128)	5.100 (129.540)
M	3.590 (91.186)	3.520 (89.408)	3.300 (83.820)	V	5.690 (144.526)	5.620 (142.748)	5.400 (137.160)
N	3.890 (98.806)	3.820 (97.028)	3.600 (91.440)	W	5.990 (152.146)	5.920 (150.368)	5.700 (144.780)
P	4.190 (106.426)	4.120 (104.648)	3.900 (99.060)	Y	6.290 (159.766)	6.220 (157.988)	6.000 (152.400)
R	4.490 (114.046)	4.420 (112.268)	4.200 (106.680)	Z	6.590 (167.386)	6.520 (165.608)	6.300 (160.020)

1/ Dimensions are in inches.

2/ Metric equivalents are given for general information only.

40.1.2 Module fin structure. The module fin shall perform the following functions:

- (a) Module identification.
- (b) Module cooling.
- (c) Module extraction and insertion.

These functions may be performed by one or more fins depending on the module configuration. The number of fins and fin locations will depend on the module design.

40.1.2.1 Module identification fin. The module identification fin shall have the configuration shown on view B of figure 12, and shall be located in the A increment of the module.

40.1.2.2 Module cooling fins. The minimum number of cooling fins required on a module shall be determined by the power dissipation requirements of 40.2.2. Any module design dissipating greater than 60 percent of the maximum recommended power shall have fins or ribs at all increments. The fin cross section and spacing shall be as specified on figure 12, view A.

40.1.2.3 Module extractor fin. Modules less than seven increments thick shall have one extractor fin. The fin shall be located in the first module increment in which there is a connector. The fin configuration shall be as specified on figure 12, view B. Modules seven or more increments thick shall have two extractor fins. One fin shall meet the requirements for modules less than seven increments. The other fin shall be located within the last two module increments, and it shall meet the configuration requirements specified on figure 12, view A. Module extractor fins shall have extractor holes as specified on figures 8 and 9. When the insertion and extraction fin is not the marking fin, it shall be identified as specified on figure 12. Unmarked single fins are shown on figure 13.

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40.1.2.4 Module extractor fin integrity. The extractor fin structure shall provide the strength required to install and extract the module and meet the requirements of 40.1.5.1.

40.1.2.5 Fin torque. The module shall withstand a 6 inch-pound (0.68 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the fin.

40.1.2.6 Fin cantilever load. The fin shall withstand a force of 2 pounds (9 newtons) applied perpendicular to the fin height along the centerline midway between the two extractor holes. The force shall be applied in two directions and shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.2.7 Module marking. See figure 14 for module marking.

40.1.3 Module rib structure. The basic size module shall have two ribs; one located at the alpha, and one located at the beta end of the module. Modules of multiple thickness shall have ribs located on the first and last increments. Ribs between the first and last increment are optional unless required for cooling. The configurations are shown on figures 8 and 9.

40.1.4 Module connector. The basic 1A module connector shall have either 20 or 40 metal blade type contacts. Multiple increment modules may have more contacts with the quantity increasing in increments of 20 contacts. Unused rows of contacts need not be present in the connector but any row of 20 contacts shall be complete. Connectors shall conform to the requirements specified herein and in MIL-C-28754. Optional connector configuration for double span modules is a 100 contact connector arranged in two rows of 50 contacts each.

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40.1.4.1 Connector location. The location of the connector on size 1A modules is limited to one position only as shown on figure 8. On multiple increment modules more than one connector may be used. The location of connectors on multiple increment modules is optional providing the location conforms with the requirements for multiple increment modules as shown on figure 9. The location of connectors on multiple increment modules shall be in accordance with the detail specification. Connectors will normally be located in the A increment on the multiple thickness modules and at the alpha end of the multiple span modules.

40.1.4.2 Connector and contact designator. Each module connector shall be assigned an alpha numeric designation to identify its location on the module. Each connector contact is assigned a number from 1 to 40 or 1 to 20. Designation of connectors and contacts by this method, as illustrated on figure 13, provides a means for complete identification of any contact on the module. All 100 contact connectors shall have the contacts numbered from 1 to 100 as shown on figure 13.

40.1.4.3 Multiple thickness modules. On multiple thickness modules, connectors shall be assigned letter designations A, B, C, and so forth, to conform with the module thickness designations. The connector location at the extreme right, as illustrated on figure 13 shall be designated A; also, all connectors and connector locations in the same span row shall be designated A. The next connector location to the left and all connector locations within this span row are designated B, and so forth. Thickness designation marking is not required.

40.1.4.4 Multiple span modules. On multiple span modules, connectors shall be assigned number designations 1, 2, 3, and so forth, to conform with the module span designations. Single-span modules are designated as 1; multiple span modules have designations 2, 3, and so forth. Connectors located within each span are designated with that span number (see figure 9). Span identification is not required for use of 100 contact connectors. Span designation marking is not required.

40.1.4.5 Connector contact identification. Each module shall have contacts identified by numbers 1, 20, 21, and 40 marked at locations shown on figure 13. Contact numbers 21 and 40 need not be identified when the contacts are not in the module or when in multiple thickness modules. Contacts 21 and 40 are located in the A increment. In multiple thickness modules, when contacts are not located in the first or last module increment, numbers 1 and 20 shall be marked on the pin shield of the A increment. When the module employs a 100 contact connector, the module shall have contacts identified by numbers 1, 50, 51, and 100 marked at locations shown on figure 14.

40.1.4.6 Contact location. The location of contacts for a typical 1A module shall be as shown on figure 8.

40.1.5 Module mechanical requirements. The following mechanical requirements apply

40.1.5.1 Module integrity. Each module, with the connector assembled, shall withstand without damage or separation a minimum axial force equal to the product of 12 ounces (3.3 newtons) multiplied by the number of contacts (for example, 12 ounces (3.3 newtons) multiplied by 40 contacts equals 480 ounces or 30 pounds (133 newtons)). The force shall be applied along the contact length in both directions. The total computed force shall be applied simultaneously to all module connector contacts to simulate module insertion and extraction. The force shall be obtained in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.2 Durability. The module shall withstand 500 cycles of mating and unmating with no degradation of module performance.

40.1.5.3 Module retention. On multiple increment modules, the use of slotted holddown bolts is permitted. Holes for the module holddown bolts shall be located at the 0.300 inch (7.620 mm) thickness increment centerline and the 2.200 inch (55.880 mm) keying pin dimension as shown on figure 15. The hole configuration is optional but shall provide a captive feature for 0.112-40 UNC-2A holddown bolts which will permit a minimum of 0.015 inch (0.381 mm) radial float. The captive bolts shall extend 0.200 to 0.270 inch (5.080 to 6.858 mm) beyond the interface plane with the 0.112

inch (2.845 mm) diameter extension below the interface plane being fully threaded. Captive means shall ensure the bolt does not interfere with the insertion and extraction of the module. Holddown bolts shall not be located in the first module connector increment. Holddown bolts are required if any of the following conditions exist:

- (a) Module exceeds 2.5 ounces (71 grams) per increment (that is, 5 ounces (142 grams) for size 1B or 2A).
- (b) Module exceeds a total weight of 4 pounds (1.81 kilograms (kg)).
- (c) Module exceeds 12 increments in thickness.

40.1.5.4 Anodic treatment. Surfaces of aluminum alloys shall be in accordance with the requirements of MIL-A-8625 (type optional, except for pin shields which shall be type III, class 2, black).

40.1.5.5 Module surface finish. The surface finish of the module shall be free of any imperfections that have a detrimental effect upon the performance of the module.

40.1.6. Color. The color of the anodized module fin (or fins) shall be lusterless black within the color range established by color chips 34052, 35042, 36076, 37038, and 37056 of FED-STD-595. The color of the remainder of the module is optional.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that CCT and TCCT are not exceeded under any of the following conditions when modules are operated at maximum power and at the maximum thermal interface temperature for the appropriate class.

- (a) Heat removed from the modules through the fins only.
- (b) Heat removed from the module through the ribs only.

40.2.2 Recommended module power dissipation. The maximum recommended power dissipation for format A modules shall be 2.5 watts for the basic 1A configuration. For modules having multiple thickness increments (for example, 1B, 1C, 1D, and so forth), the maximum recommended power dissipation shall be increased by 1.50 watts per additional thickness increment. The maximum recommended power dissipation for format A configurations having multiple spans shall be determined by cumulative addition at the maximum recommended power dissipation for single span modules (for example, format A configuration 1A = 2.5 watts; format A configuration 1B = 4.0 watts; format A configuration 2A = 5.0 watts; format A configuration 2B = 8.0 watts, and so forth). The power deratings reflected above for additional module thickness increments are the result of imperfect alignments between the module guide ribs and the system level heat sink structure when utilizing guide rib conduction cooling. Detail specifications covering any module design dissipating greater than the above recommended values shall have the configuration of the heat dissipating features and the method of cooling specified for future application guidance on the use of the module.

40.2.2.1 Determination of maximum power. Maximum power is determined by the worst case operating conditions of the module. Factors influencing power are voltage, frequency, duty cycle, loads, and any other characteristic that produce the highest current. The power for digital modules is to be determined with no load connected to the output. The power for analog modules is to be determined with the maximum load connected to the output.

40.2.3 Component temperatures. The following requirements for CCT and TCCT apply.

40.2.3.1 CCT. The CCT for semiconductor devices shall be 105°C junction for classes I and III and 130°C junction for classes II and IV. For all other components, the CCT shall be equal to the individual component's maximum specified operating temperature minus 20°C and shall be specified on the component's hottest external area for the thermal interface held at maximum temperature for the applicable class.

40.2.3.2 TCCT. The TCCT for all devices shall be the appropriate CCT plus 20°C

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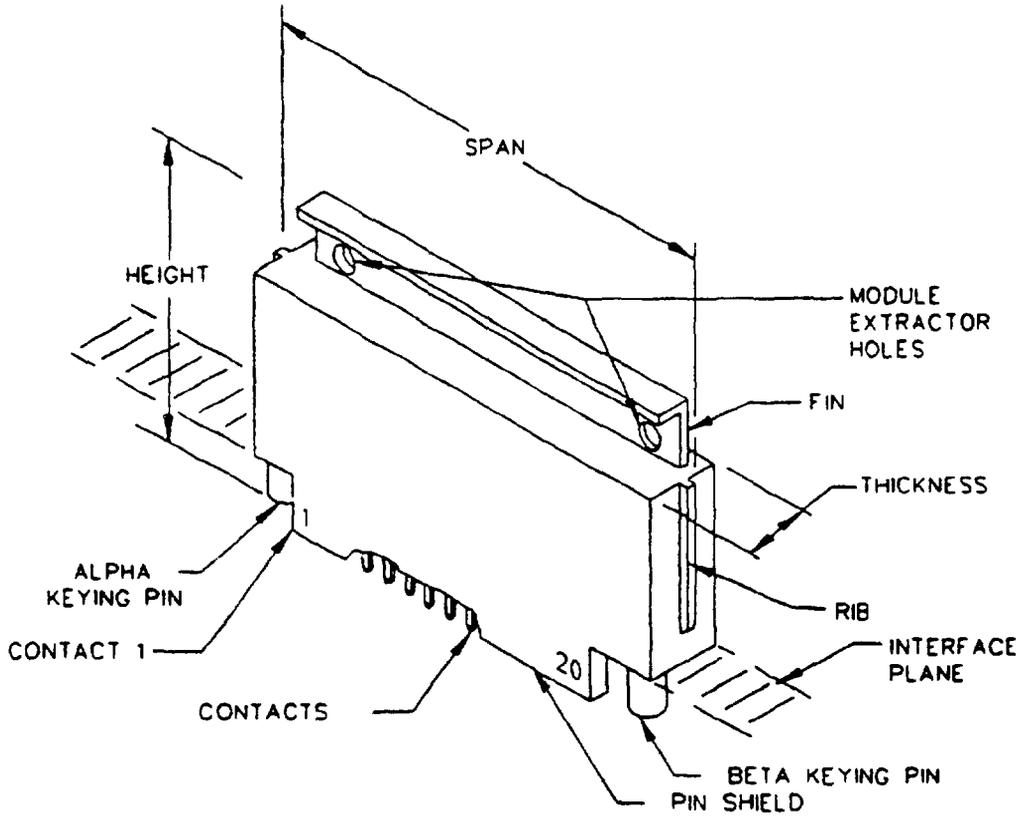
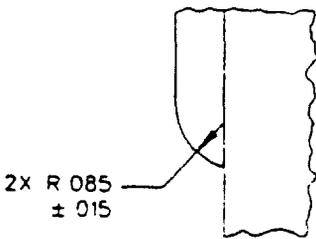
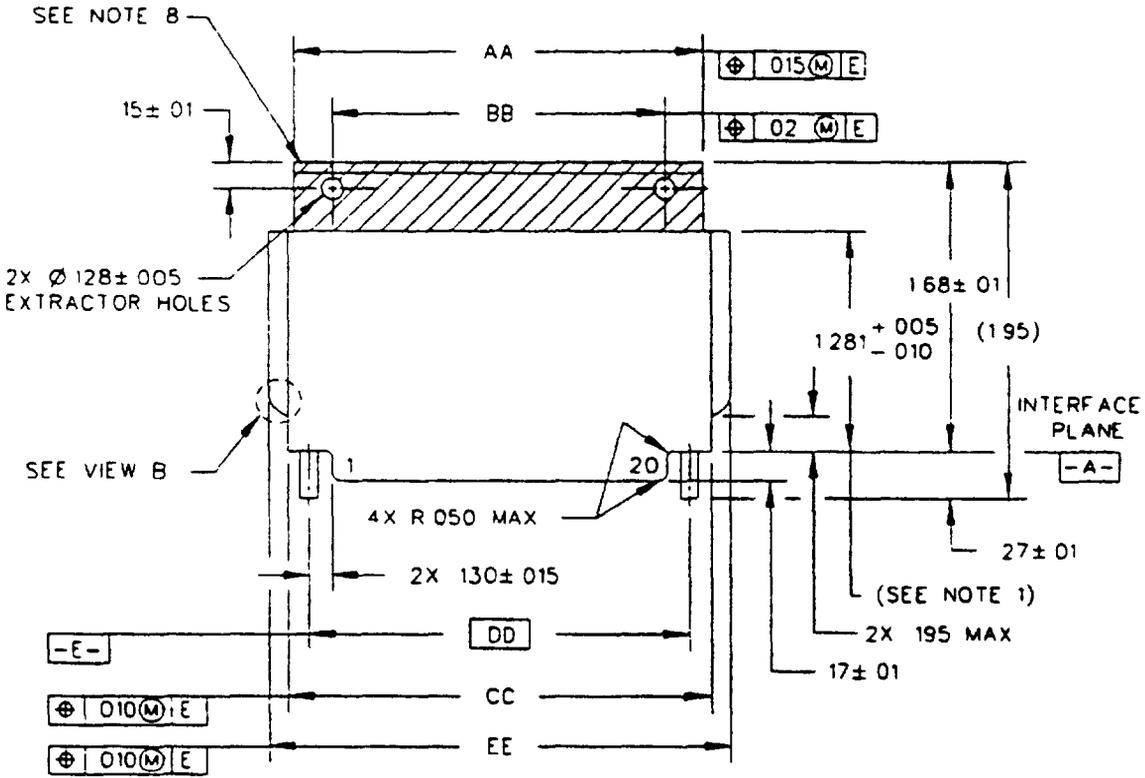
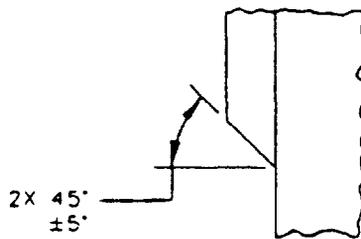


FIGURE 7. Module outline.

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METHOD 1



METHOD 2

OPTIONAL CONFIGURATION

VIEW B

FIGURE 8. Module basic size outline

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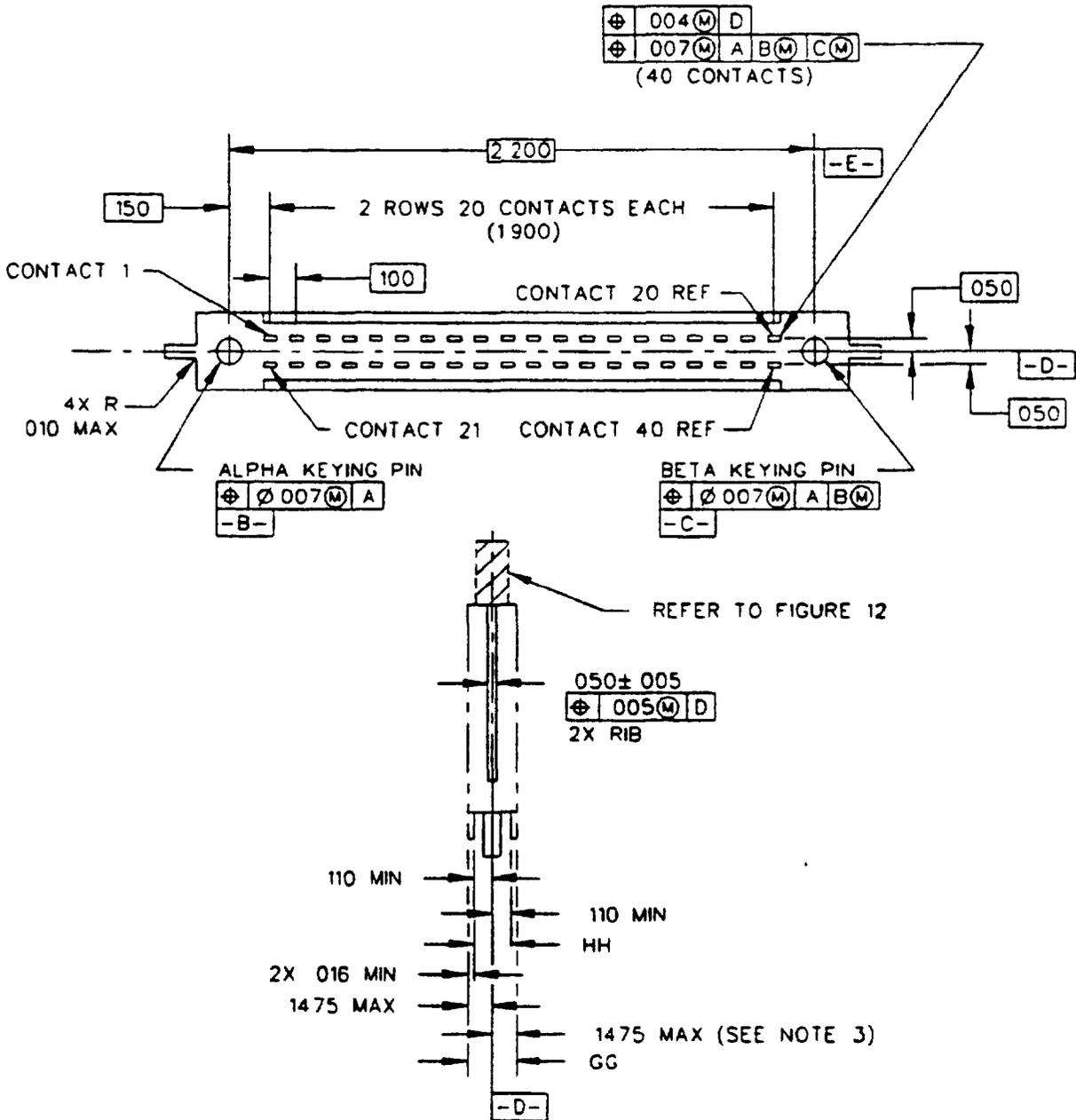


FIGURE 8. Module basic size outline - Continued.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.004	0.102	0.016	0.406	0.128	3.251	1.281	32.54
0.005	0.127	0.02	0.51	0.130	3.302	1.68	42.68
0.007	0.178	0.050	1.270	0.1475	3.7465	1.900	48.260
0.010	0.254	0.085	2.159	0.15	3.81	1.95	49.53
0.01	0.25	0.100	2.540	0.17	4.32	2.200	55.880
0.015	0.381	0.110	2.794	0.195	4.953		

NOTES:

1. The 1.281 plus 0.005, minus 0.010 inches (32.537 plus 0.127, minus 0.254 mm) dimension applies from the interface surface to the top of the rib only. The portion of the module other than the top surface of the rib (that is, within the CC dimension) shall be 1.286 inch (32.664 mm) maximum
2. See table VI for letter dimensions
3. The 0.1475 inch (3.7465 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimension GG maximum governs.
4. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
5. Datum plane E is established by the two keying pin features at their virtual condition.
6. Dimensions are in inches.
7. Metric equivalents are given for general information only.
8. For extraction purposes, this area must be free of obstruction.

FIGURE 8. Module basic size outline - Continued

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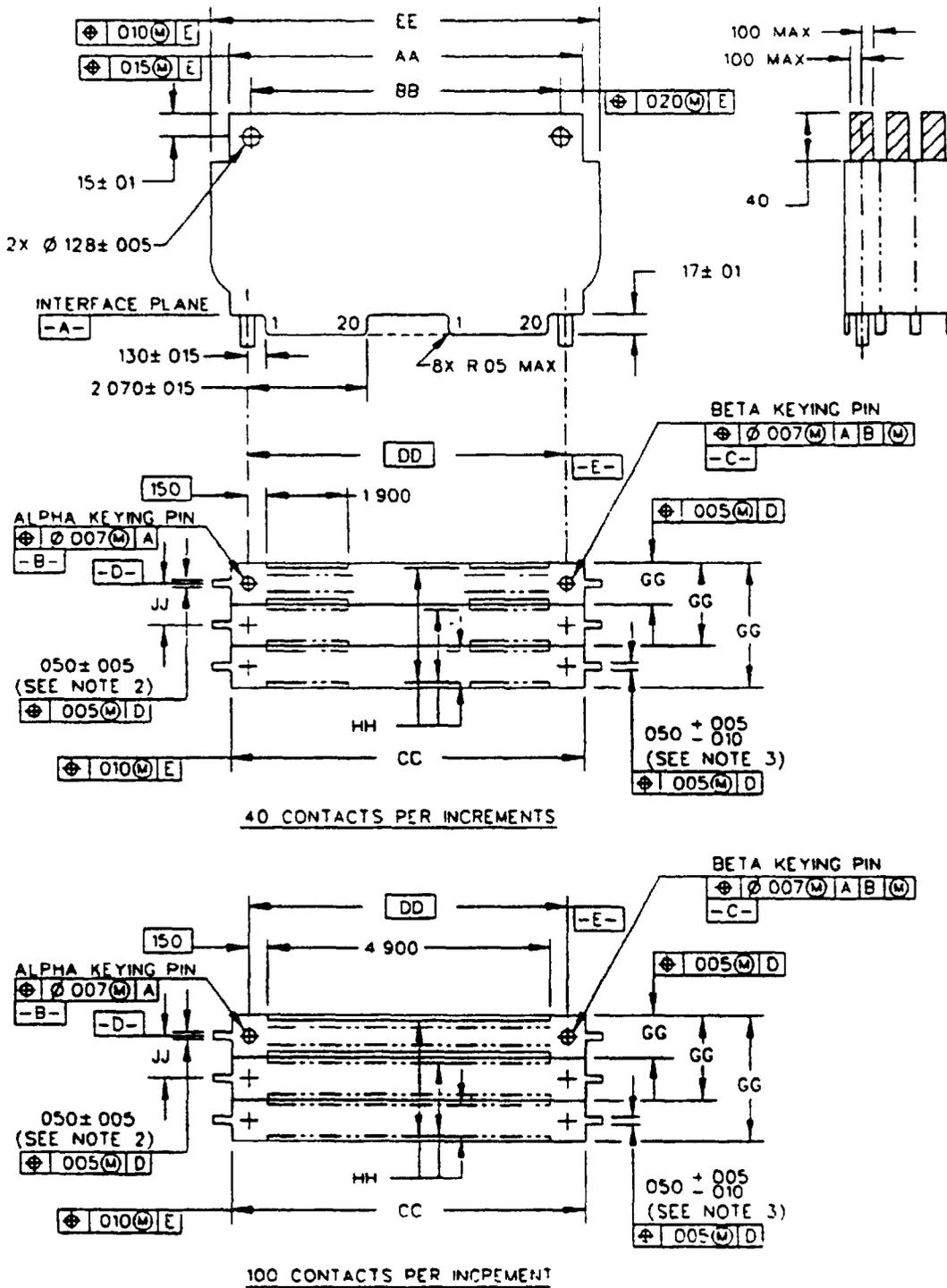


FIGURE 9. Multiple increment module outline

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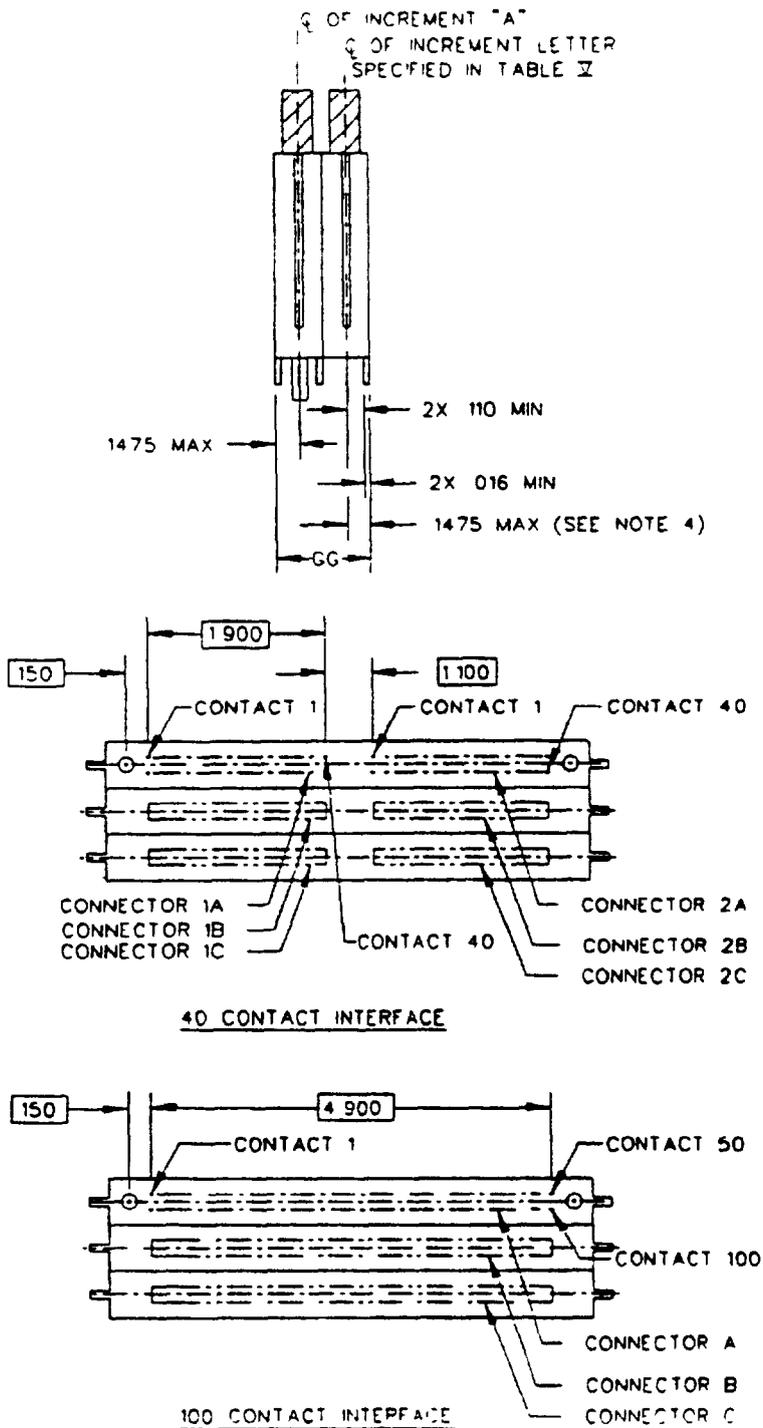


FIGURE 9. Multiple increment module outline - Continued.

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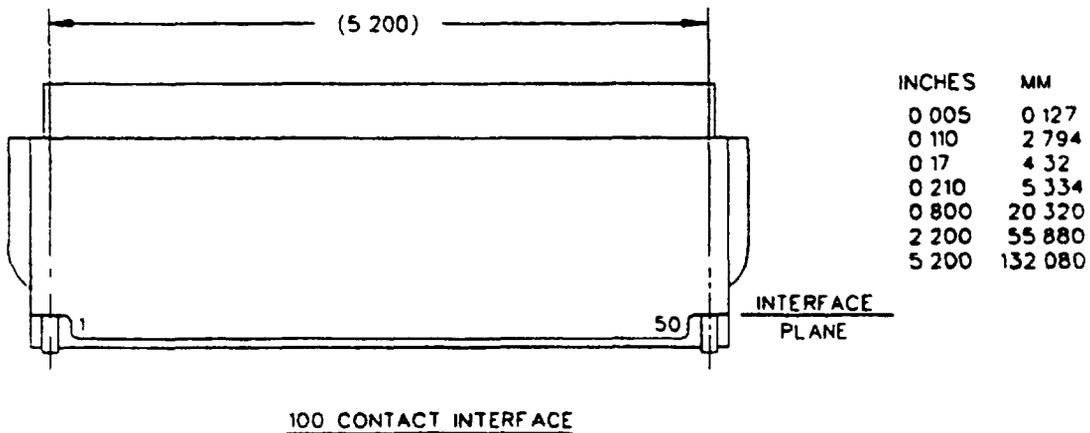
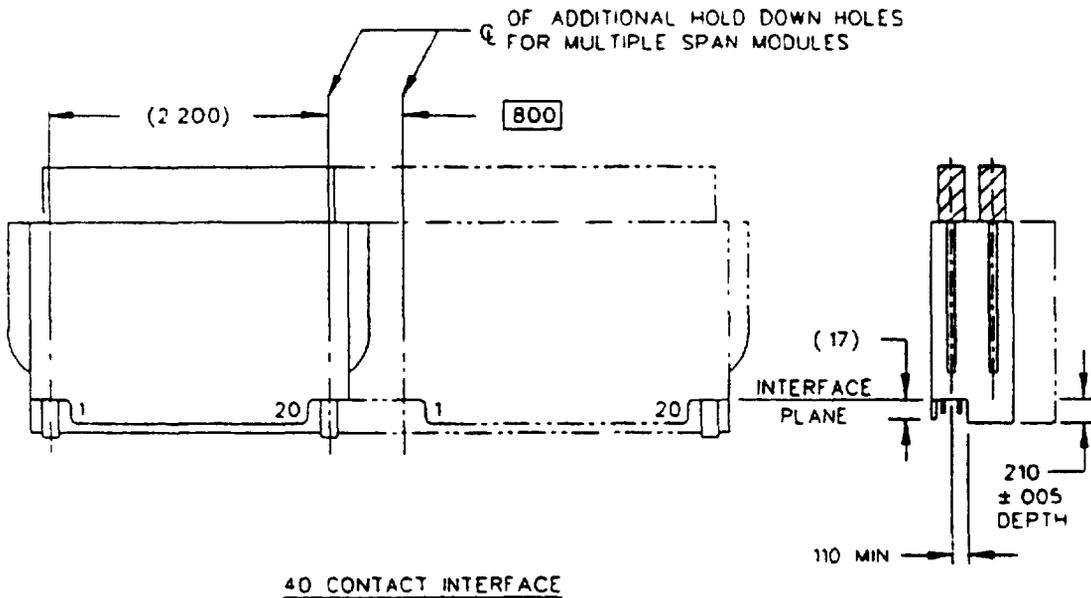
Inches	mm	Inches	mm	Inches	mm
0.005	0.127	0.05	1.27	0.17	4.32
0.007	0.178	0.100	2.540	0.40	10.16
0.010	0.254	0.110	2.794	1.100	27.940
0.01	0.25	0.128	3.251	1.900	48.260
0.015	0.381	0.130	3.302	2.070	52.578
0.016	0.406	0.1475	3.7465	4.900	124.460
0.020	0.508	0.150	3.810		
0.050	1.270	0.15	3.81		

NOTES:

1. Module pin shields are only required for the external protection of contacts and are not required for module increments which do not contain contacts.
2. The 0.050 plus or minus 0.005 inch (1.270 plus or minus 0.127 mm) dimension applies to the first module increment only.
3. The 0.050 plus 0.005, minus 0.010 inch (1.270 plus 0.127, minus 0.254 mm) dimension applies to all module increments except the first.
4. The 0.1475 inch (3.7465 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimensions GG maximum governs.
5. See table VI for letter dimensions.
6. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
7. Datum plane E is established by the two keying pin features at their virtual condition.
8. Dimensions are in inches.
9. Metric equivalents are given for general information only.

FIGURE 9 Multiple increment module outline - Continued.

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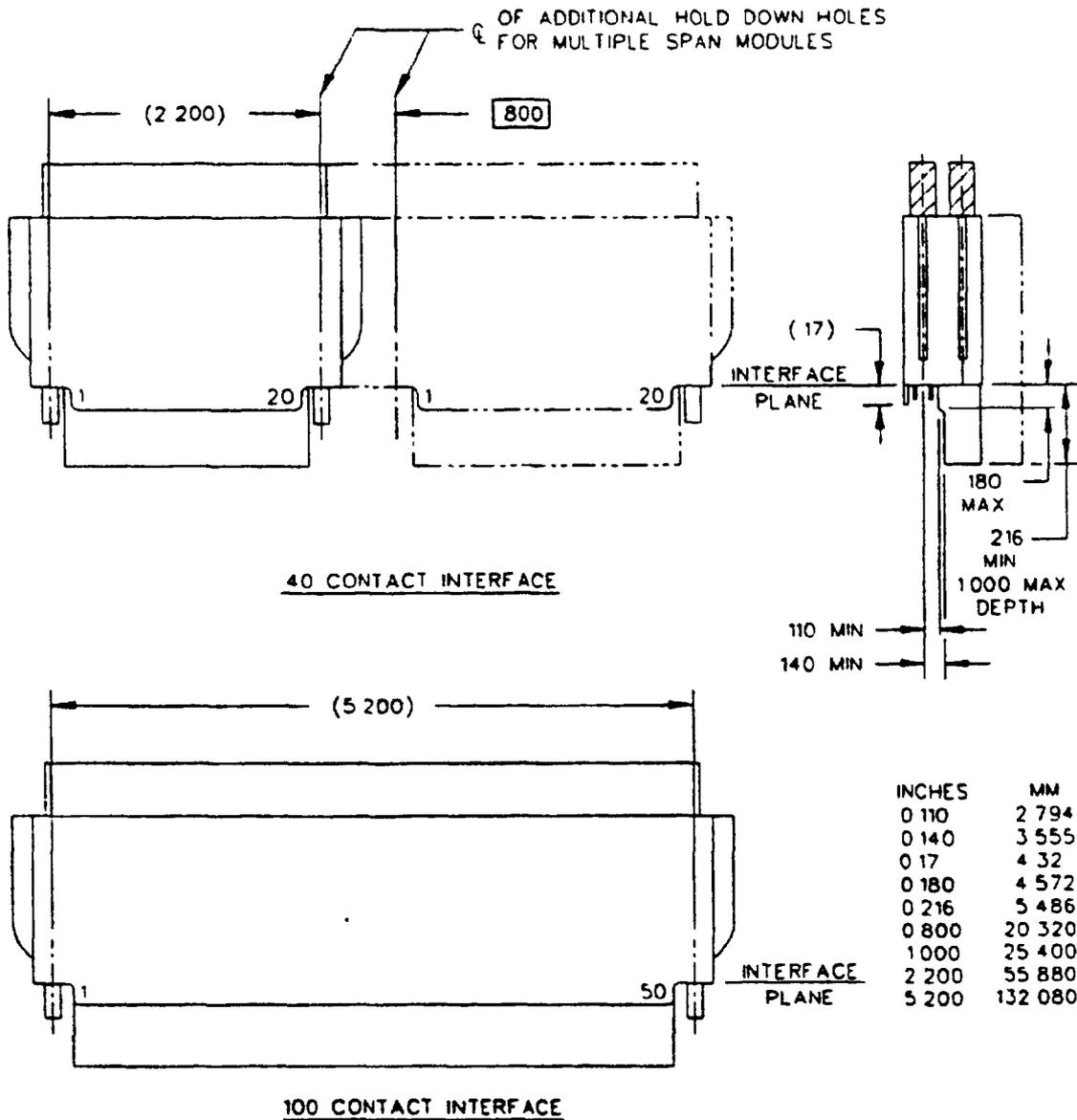


NOTES:

1. Modules in this configuration require modification to the mated interface plane (mounting plate).
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.

FIGURE 10. Plate mounted module outline.

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NOTES:

1. Modules in this configuration require modification to the mated interface plane (mounting plate).
2. Dimensions are in inches.
3. Metric equivalents are given for general information only

FIGURE 11. Sub-plate mounted module outline

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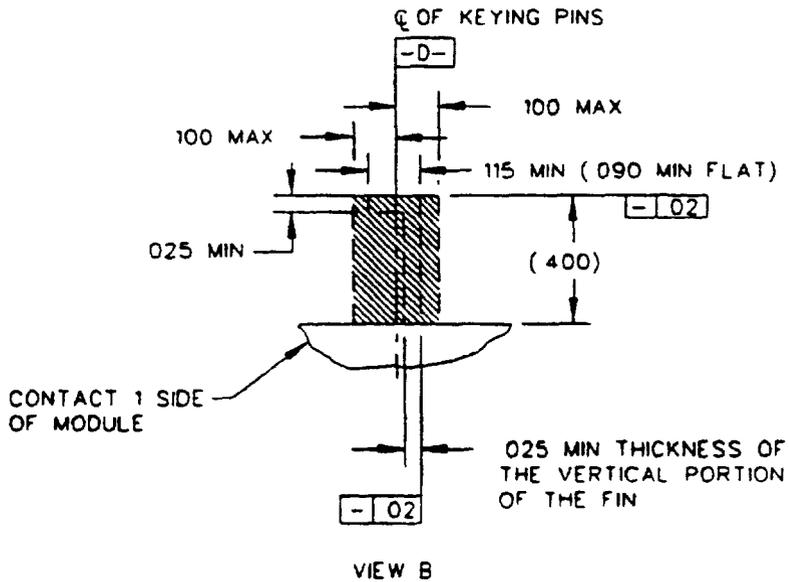
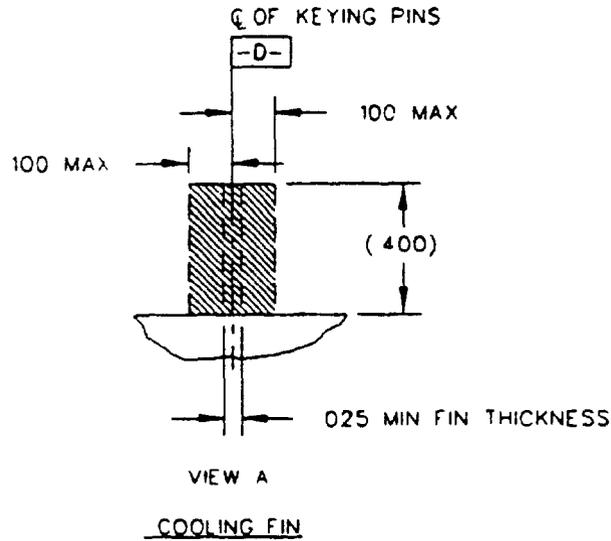
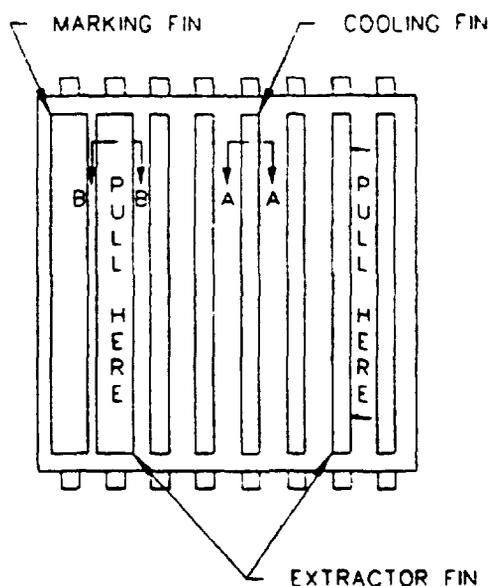


FIGURE 12. Identification, insertion, extractor, and cooling fin outline.

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Inches	mm	Inches	mm	Inches	mm
0.02	0.51	0.090	2.286	0.115	2.921
0.025	0.635	0.100	2.540	0.400	10.160

NOTES:

1. Location of vertical portion of fin optional within shaded area.
2. Cross sectional area of the entire fin shall not exceed 40 percent of shaded area.
3. Dimensions are in inches.
4. Metric equivalents are given for general information only.

FIGURE 12 Identification, insertion, extractor, and cooling fin outline - Continued.

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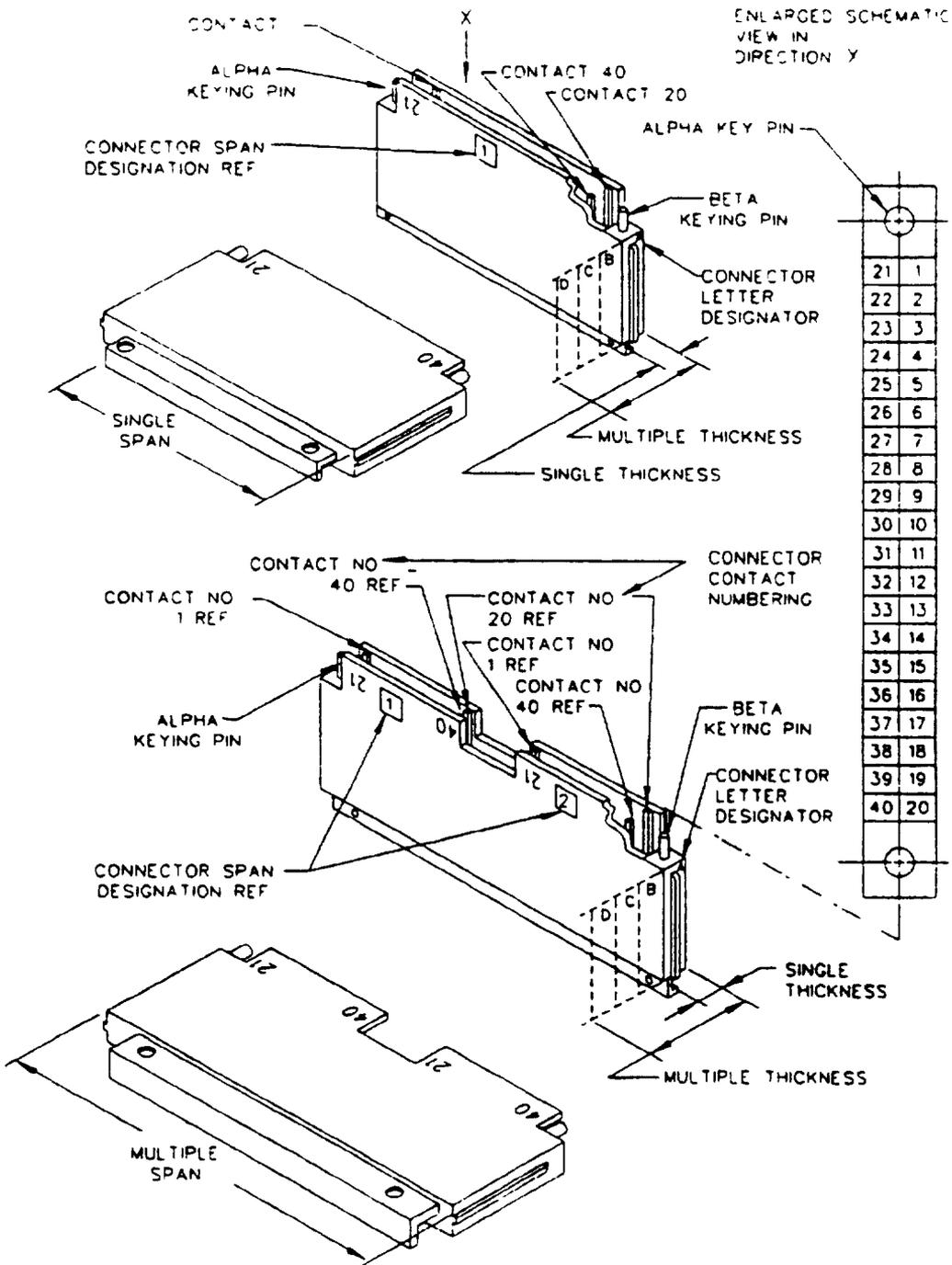


FIGURE 13 Connector contact assignment.

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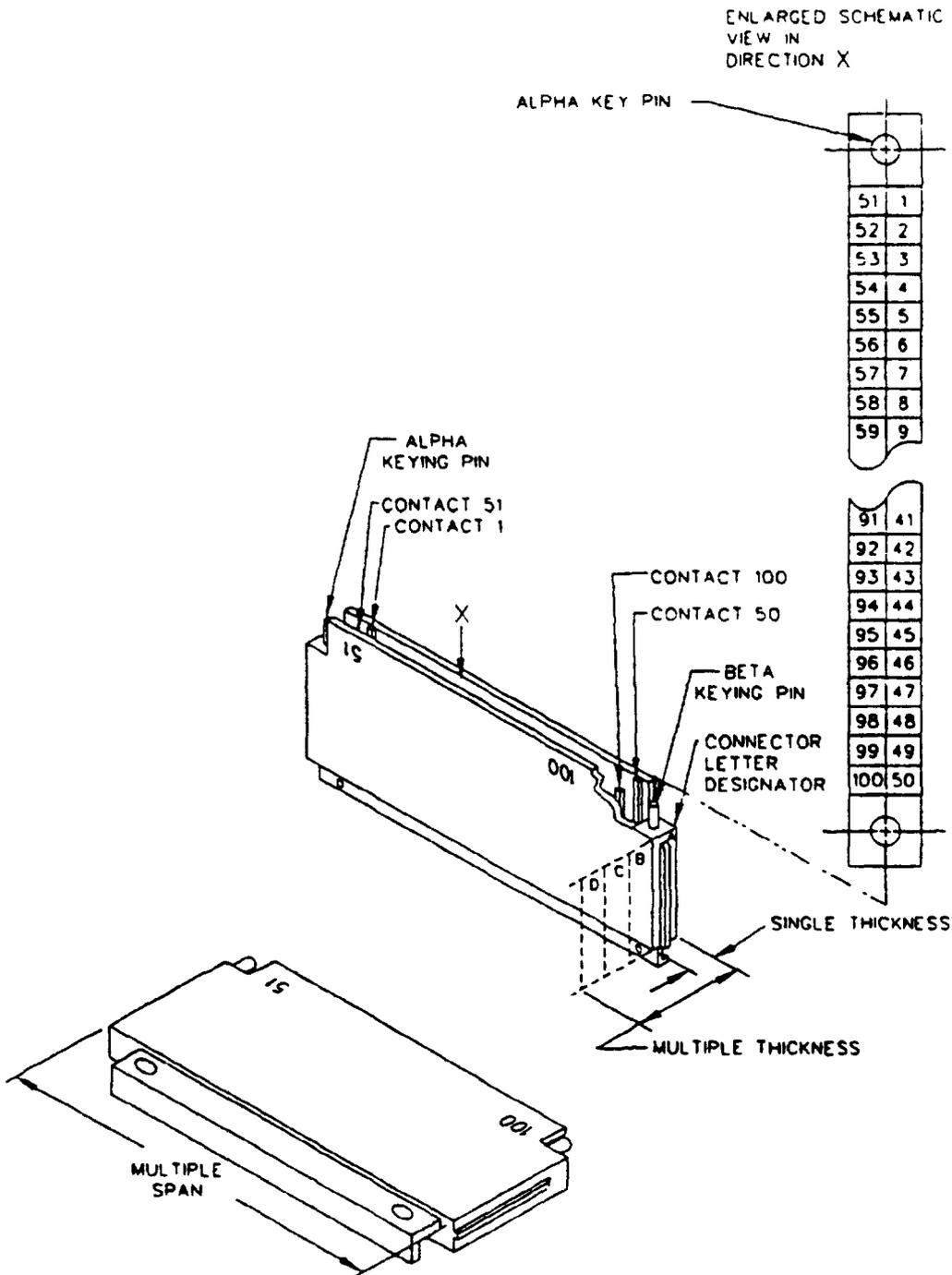
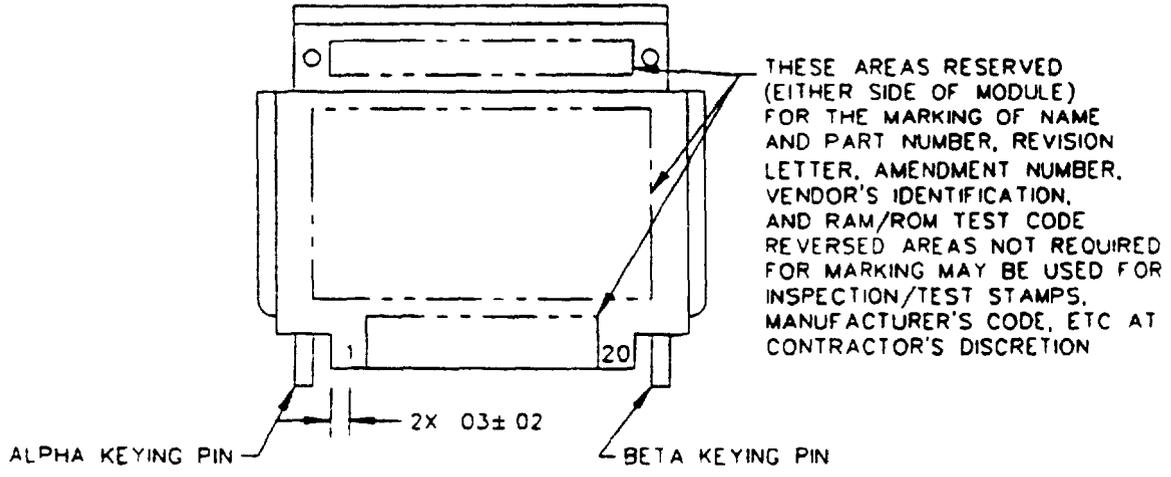
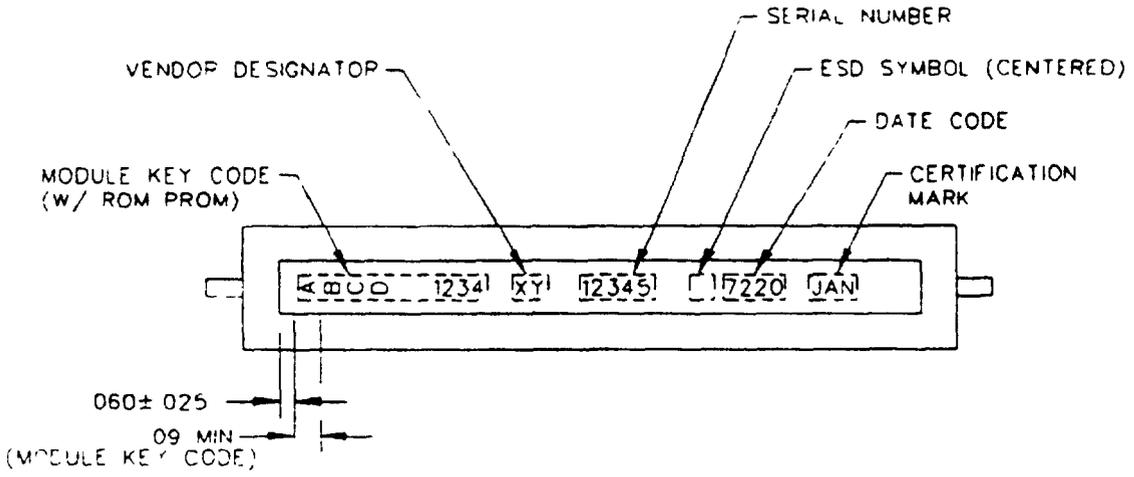


FIGURE 13. Connector contact assignment - Continued.

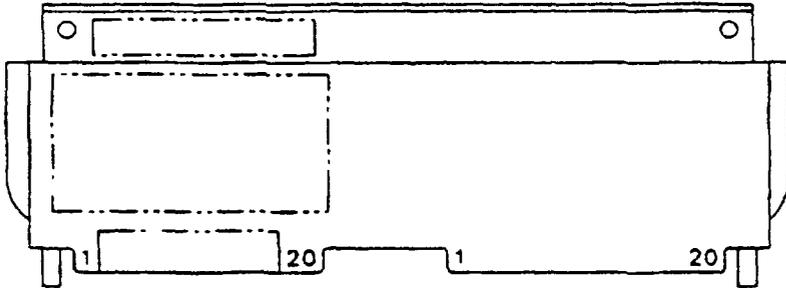
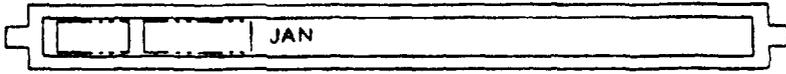
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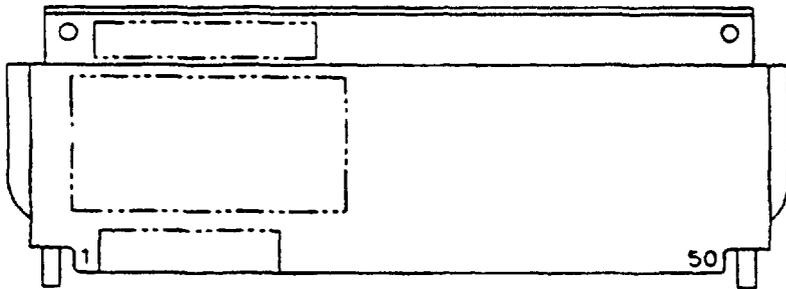
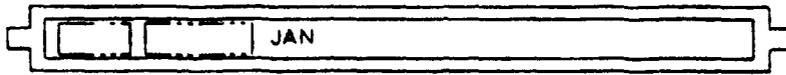
SINGLE SPAN

FIGURE 14. Module marking areas.

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FORMAT A
MULTIPLE SPAN (SEE NOTE 1)



FORMAT A
MULTIPLE SPAN (SEE NOTE 1)

FIGURE 14. Module marking areas - Continued.

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Inches	mm
0.02	0.51
0.025	0.635
0.03	0.76
0.060	1.524
0.09	2.286

NOTES:

1. All marking performed on a multiple span module shall be the same and located in the same areas as a single span module.
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.
4. The 0.060 spacing between the fin end and the key code shall be measured between the first letter of the key code and that part of the fin nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum.

FIGURE 14. Module marking areas - Continued

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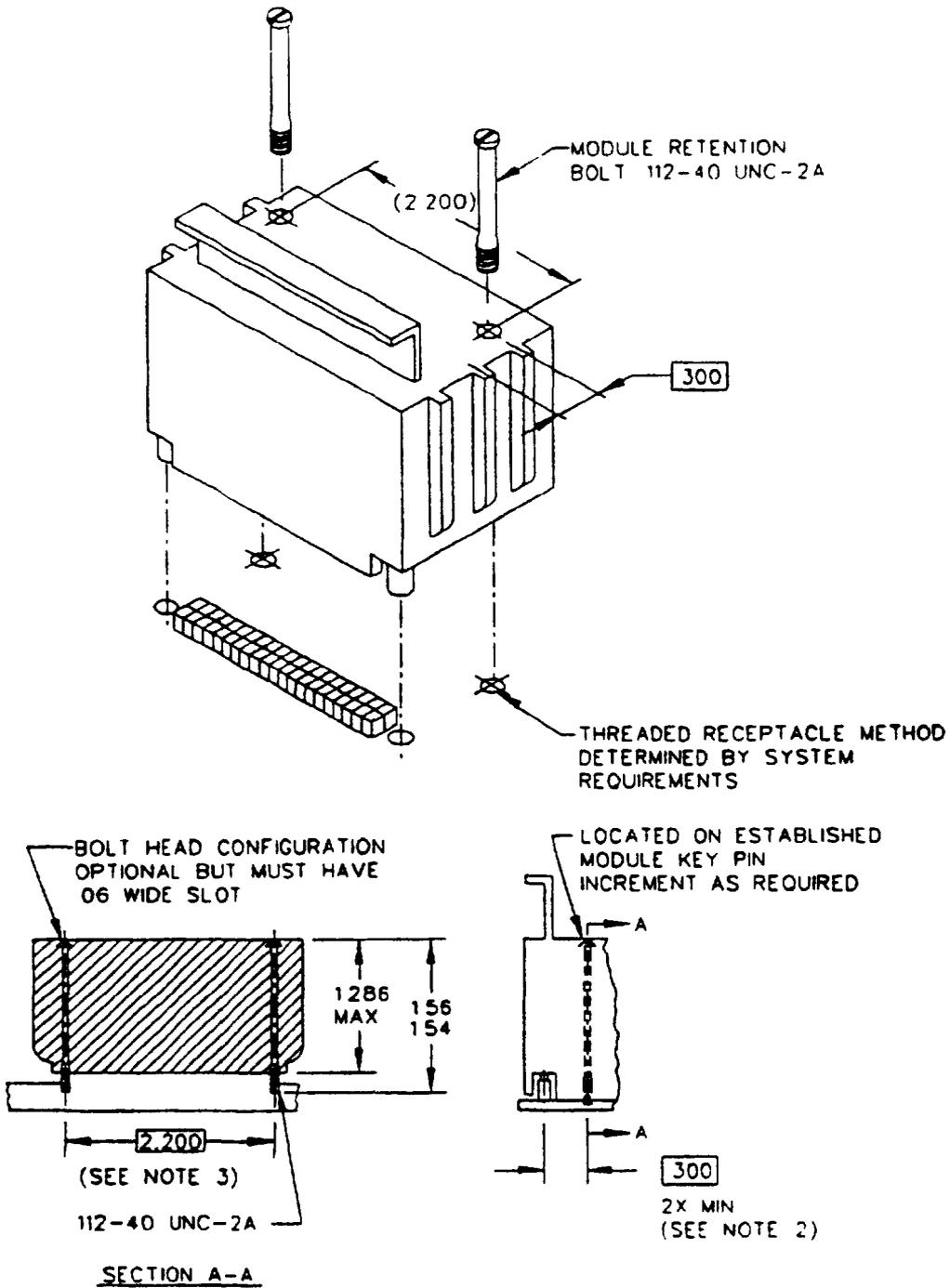


FIGURE 15. Module retention bolt interface.

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Inches	mm
0.06	1.52
0.112	2.845
0.300	7.620
1.286	32.664
1.54	39.16
1.56	39.62
2.200	55.880

NOTES-

1. When holddown bolts are in their secured position, the head of the bolt shall be within the 1.286 inch (32.664 mm) dimension.
2. A minimum of two holddown bolts, when required, shall be provided at both the alpha and beta ends of the module increment in which they are located.
3. Clearance holes 0.142 inch (3.606 mm) diameter minimum $\text{⌀} 0.10 \text{ (M)} \text{ E}$ (0.254 mm), 2 holes, 2.200 inch apart.
4. Dimensions are in inches.
5. Metric equivalents are given for general information only.

FIGURE 15. Module retention bolt interface - Continued.

APPENDIX B

DESIGN REQUIREMENTS FOR FORMAT B MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of the standard for the design requirements for format B modules to be used in SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix

30. GENERAL REQUIREMENT

30.1 Mechanical configuration requirements. The basic mechanical configurations for format B are the single-span, single-thickness module specified on figures 16 and 17 and in table VII. Drawing practices shall be in accordance with DOD-STD-100.

30.2 Thermal requirements. Modules shall be designed to be cooled through the fin or ribs and shall be cooled by either method with no other heat loss. Modules less than C thickness shall be designed for direct air impingement cooling over the components, and in addition, shall meet the fin and guide rib cooling design requirements. For modules C thickness or greater, the design for direct air impingement cooling is optional. The cooling design for direct air impingement shall be predicated upon a maximum airflow rate of 0.10 pound mass per minute (0.008 kg per second) at the appropriate inlet air temperature for the module class interface for each "A" incremental thickness per module when tested in a duct size of 2.00 inches (50.80 mm) high and 0.315 inch (8.001 mm) wide (see figure 18). A maximum airflow rate of 0.25 pound mass per minute (0.002 kg per second) for each "A" incremental thickness per module shall be used when tested in a duct size of 2.00 inches (50.80 mm) high and 0.413 inch (10.49 mm) wide. Duct width shall be increased by 0.300 inch (7.620 mm) for each additional module thickness increment. For direct air impingement cooling, the maximum allowable static pressure loss shall be 0.11 inch (2.79 mm) of water across a single span module and 0.30 inch (7.62 mm) of water across a double span module.

40 DETAILED REQUIREMENTS

40 1 Configuration The basic size module has a span of 2.74 inches (69.60 mm), a thickness of 0.290 inch (7.366 mm) and is 1.95 inches (49.53 mm) high including keying pins. Modules may increase in span, thickness, or simultaneously in both span and thickness. For multiple increment modules, span shall be increased in 3.000 inches (76.200 mm) increments and thickness shall be increased in 0.300 inch (7.620 mm) increments as shown in table VII. Module configurations and size designations shall conform to the span and thickness matrix of table VII. Dimensions and tolerances shall be as specified on figures 17 and 19. Plate mounted modules shall be as specified on figure 20 and sub-plate mounted modules shall be as specified on figure 21

TABLE VII. Module span and thickness increments. 1/ 2/

Span <u>3/</u> 3 00 in. (76.20 mm) increments)		Thickness <u>4/</u>					
Span design	Dim Inch mm	A 0.290 (7.366)	B 0.590 (14.986)	C 0.890 (22.606)	D 1.190 (30.226)	E 1.490 (37.846)	F 1.790 (45.466)
1	2.74 (69.60)	1A	1B	1C	1D	1E	1F
2	5.74 (148.80)	2A	2B	2C	2D	2E	2F
3	8.74 (222.00)	3A	3B	3C	3D	3E	3F

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TABLE VII. Module span and thickness increments. - Continued. 1/ 2/

G 2.090 (53.086)	H 2.390 (60.706)	J 2.690 (68.326)	K 2.990 (75.946)	L 3.290 (83.566)	M 3.590 (91.186)	N 3.890 (98.806)	P 4.190 (106.426)
1G	1H	1J	1K	1L	1M	1N	1P
2G	2H	2J	2K	2L	2M	2N	2P
3G	3H	3J	3K	3L	3M	3N	3P

R 4.490 (114.046)	S 4.790 (121.666)	T 5.090 (129.286)	U 5.390 (136.906)	V 5.690 (144.526)	W 5.990 (152.146)	Y 6.290 (159.766)	Z 6.590 (167.386)
1R	1S	1T	1U	1V	1W	1Y	1Z
2R	2S	2T	2U	2V	2W	2Y	2Z
3R	3S	3T	3U	3V	3W	3Y	3Z

- 1/ Dimensions are in inches.
- 2/ Metric equivalents are given for general information only.
- 3/ Span is measured across the ribs.
- 4/ Each letter is 0.300 inch (7.620 mm) greater than the previous letter with "A" equal to 0.290 inch (7.366 mm) maximum.

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TABLE VIII Module span and thickness dimensions (see figures 17 and 19 for details). 1/ 2/

Span	Dimensions				
	AA ±0.01 (0.25)	BB ±0.01 (0.25)	CC +0.005 (0.127) -0.075 (1.905)	DD basic	EE ±0.01 (0.25)
1	2.32 (58.93)	1.89 (48.01)	2.440 (61.976)	2.200 (55.880)	2.74 (69.60)
2	5.32 (135.13)	4.89 (124.21)	5.440 (138.176)	5.200 (132.080)	5.74 (145.80)
3	8.32 (211.33)	7.89 (200.41)	8.440 (214.376)	8.200 (208.280)	8.74 (222.00)

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
A	0.290 (7.366)	0.220 (5.588)	0
B	0.590 (14.986)	0.520 (13.208)	0.300 (7.620)
C	0.890 (22.606)	0.820 (20.828)	0.600 (15.240)
D	1.190 (30.226)	1.120 (28.448)	0.900 (22.860)

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
E	1.490 (37.846)	1.420 (36.068)	1.200 (30.480)
F	1.790 (45.466)	1.720 (43.688)	1.500 (38.100)
G	2.090 (53.086)	2.020 (51.308)	1.800 (45.720)
H	2.390 (60.706)	2.320 (58.928)	2.100 (53.340)

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TABLE VIII. Module span and thickness dimensions (see figures 17 and 19 for details). - Continued. 1/ 2/

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
J	2.690 (68.326)	2.620 (66.548)	2.400 (60.960)
K	2.990 (75.946)	2.920 (74.168)	2.700 (68.580)
L	3.290 (83.566)	3.220 (81.788)	3.000 (76.200)
M	3.590 (91.186)	3.520 (89.408)	3.300 (83.820)
N	3.890 (98.806)	3.820 (97.028)	3.600 (91.440)
P	4.190 (106.426)	4.120 (104.648)	3.900 (99.060)
R	4.490 (114.046)	4.420 (112.268)	4.200 (106.680)

Thick- ness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
S	4.790 (121.666)	4.720 (119.888)	4.500 (114.300)
T	5.090 (129.286)	5.020 (127.508)	4.800 (121.920)
U	5.390 (136.906)	5.320 (135.128)	5.100 (129.540)
V	5.690 (144.526)	5.620 (142.748)	5.400 (137.160)
W	5.990 (152.146)	5.920 (150.368)	5.700 (144.780)
Y	6.290 (159.766)	6.220 (157.908)	6.000 (152.400)
Z	6.590 (167.386)	6.520 (165.608)	6.300 (160.020)

1/ Dimensions are in inches.

2/ Metric equivalents are given for general information only.

40.1.1 Circuitry External circuitry and components shall be contained within an area defined by the following: A minimum of 0.050 inch (1.270 mm) inward on each side from two vertical parallel lines established by the CC dimension and a maximum of 1.645 inches (41.783 mm) measured vertically from the interface plane (see figure 17). The printed board shall be further reduced by the crosshatched area shown on figure 17 to allow for insertion of the module extractor without component damage, and to allow for any curvature of the frame from the rib edge to the flat surface.

40.1.2 Module fin structure. The module fin shall perform the following functions:

- (a) Module identification.
- (b) Module cooling.
- (c) Module extraction and insertion.

These functions may be performed by one or more fins depending on the module configuration. The number of fins and fin locations will depend on the module design.

40.1.2.1 Module identification fin. The module identification fin shall have the configuration shown on figure 22 and shall be located in the A increment of the module.

40.1.2.2 Module cooling fins. The minimum number of cooling fins required on a module shall be determined by the power dissipation requirements of 40.2.2. The fin cross section and spacing shall be as shown on figure 22.

40.1.2.3 Module extractor fin Modules less than seven increments thick shall have a minimum of one extractor fin. The fin shall be located in the first module increment in which there is a connector. The fin configuration shall be as shown on figure 22. Modules seven or more increments thick shall have two extractor fins. One fin shall meet the requirements for modules less than seven increments. The other fin shall

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be located within the last two module increments and it shall meet the configuration requirements shown on figure 22. Module extractor fins shall have extractor holes as shown on figures 17 and 19. When the insertion and extraction fin is not the marking fin, it shall be identified as illustrated on figure 23.

40.1.2.4 Module extractor fin integrity. The extractor fin structure shall provide the strength required to install and extract the module and meet the requirements of 40.1.5.1.

40.1.2.5 Fin torque. The module shall withstand a 6 inch-pound (0.68 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the fin.

40.1.2.6 Fin cantilever load. The fin shall withstand a force of 2 pounds (9 newtons) applied perpendicular to the fin height along the centerline midway between the two extractor holes. The force shall be applied in two directions and shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.2.7 Module marking. See figure 24 for module marking.

40.1.3 Module rib structure. The basic size module shall have two ribs; one located at the alpha end, and one located at the beta end of the module. Modules of multiple thickness shall have ribs located on the first and last increments. Ribs between the first and last increment are optional unless required for cooling. The configurations are shown on figures 17 and 19.

40.1.4 Module connector. The basic 1A module connector shall have either 20 or 40 metal blade contacts. Multiple increment modules may have more contacts with the quantity increasing in increments of 20 contacts. Unused rows of contacts need not be present in the connector but any row of 20 contacts shall be complete. Connectors shall conform to MIL-C-28754 or the requirements specified herein. Double span modules shall use the 100-contact connector.

40.1.4.1 Connector location The location of connector on size 1A modules is limited to one position only as shown on figure 17. On multiple increment modules, more than one connector may be used. The location of connectors on multiple increment modules is optional providing the location conforms with the requirements for multiple increment modules as shown on figure 19. The location of connectors on multiple increment modules shall be in accordance with the detail specification. Connectors will normally be located in the A increment on the multiple thickness modules and at the alpha end of the multiple span modules.

40.1.4.2 Connector and contact designator. Each module connector shall be assigned an alpha-numeric designation to identify its location on the module. Each connector contact is assigned a number from 1 to 40. Designation of connectors and contacts by this method, as illustrated on figure 24, provides a means for complete identification of any contact on the module. All 100-contact connectors shall have the contacts numbered from 1 to 100 as shown on figure 25.

40.1.4.3 Multiple thickness modules. On multiple thickness modules, connectors shall be assigned letter designations A, B, C, and so forth, to conform with the module thickness designations. The connector location at the extreme right, as illustrated on figure 25, shall be designated A; also, all connectors and connector locations in the same span row shall be designated A. The next connector location to the left and all connector locations within this span row are designated B, and so forth. Thickness designation marking is not required.

40.1.4.4 Multiple span modules. On multiple span modules, connectors shall be assigned number designations 1, 2, 3, and so forth, to conform with the module span designations. Single span modules are designated as 1, multiple span modules have designations 2, 3, and so forth. Connectors located within each span are designated with that span number (see figure 25). Span identification is not required for use of 100 contact connectors. Span designation marking is not required.

40.1.4.5 Connector contact identification. Each module shall have contacts identified by numbers 1, 20, 21, and 40 marked at locations shown on figure 25. Contact numbers 21 and 40 need not be identified when the contacts are not in the module or when in multiple thickness modules contacts 21 and 40 are located in the increment A. In multiple thickness modules when contacts are not located in the first or last module increment numbers 1 and 20 shall be marked on the pin shield of the A increment. When the module employs a 100-contact connector, the module shall have contacts identified by numbers 1, 50, 51, and 100 marked at locations shown on figure 25.

40.1.4.6 Contact location. The location of contacts for a basic size module shall be as shown on figure 17.

40.1.5 Module mechanical requirements. The following mechanical requirements apply.

40.1.5.1 Module integrity. Each module, with the connector assembled, shall withstand without damage or separation a minimum axial force equal to the product of 12 ounces (3.3 newtons) multiplied by the number of contacts (for example, 12 ounces (3.3 newtons) multiplied by 40 contacts equals 480 ounces or 30 pounds (133 newtons)). The force shall be obtained in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.2 Durability. The module shall withstand 500 cycles of mating and unmating with no degradation of module performance.

40.1.5.3 Module retention. On multiple increment modules, the use of slotted holddown bolts is permitted. Holes for the module holddown bolts shall be located at the 0.300 inch (7.620 mm) thickness increment centerline and the 2.200 inches (55.880 mm) keying pin dimension as shown on figure 26. The hole configuration is optional but shall provide a captive feature for 0.112-40 UNC-2A holddown bolts which will permit a minimum of 0.015 inch (0.381 mm) radial float. The captive bolts shall extend 0.200 to 0.270 inch (5.080 to 6.858 mm) beyond the interface plane with the 0.112 inch (2.845 mm) diameter extension below the interface plane being fully threaded. Captive means shall ensure the bolt does not interfere with the insertion and extraction of the module. Holddown bolts

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shall not be located in the first module connector increment. Hold-down bolts are required if any of the following conditions exist:

- (a) Module exceeds 2.5 ounces (71 grams) per increment (that is, 5 ounces (142 grams) for size 1B or 2A).
- (b) Module exceeds a total weight of 4 pounds (1.814 kilograms (kg)).
- (c) Module exceeds 12 increments in thickness.

40.1.5.4 Anodic treatment. Surfaces of aluminum alloys shall be in accordance with the requirements of MIL-A-8625 (type optional, except for pin shields which shall be type III, class 2, black).

40.1.5.5 Module surface finish. The surface finish of the module shall be free of any imperfections that have a detrimental effect upon the performance of the module.

40.1.5.6 Copper and copper composite frame plating. All copper and copper composite frames shall be electroless nickel plated in accordance with MIL-C-26074, class 1, grade A.

40.1.6 Color. The color of the anodized module fin (or fins) shall be lusterless black within the color range established by color chips 34052, 35042, 36076, 37038, and 37056 of FED-STD-595. The color of the remainder of the module is optional.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that CCT and TCCT are not exceeded under any of the following conditions when modules are operated at maximum power and at the maximum thermal interface temperature for the appropriate class.

- (a) Heat removed from the module through the fins only.
- (b) Heat removed from the module through the ribs only.

(c) Cooling by direct air impingement over the components

40.2.2 Recommended module power dissipation. The maximum recommended power dissipation for modules shall be 4 watts for the basic size configuration. For modules having multiple thickness increments, the maximum recommended power dissipation shall be increased by 2.5 watts per additional thickness increment. The maximum recommended power dissipation for module configurations having multiple spans shall be determined by cumulative addition at the maximum recommended power for single span modules (for example, configuration 1A = 4.0 watts; configuration 1B = 6.5 watts; configuration 2A = 8.0 watts; configuration 2B = 13.0 watts, and so forth). The power deratings reflected above for additional module thickness increments are the result of imperfect alignments between the module guide ribs and the system level heat sink structure when utilizing guide rib conduction cooling. Detail specifications covering any module design dissipating greater than the above recommended values shall have the configuration of the heat dissipating features and the method of cooling specified for future application guidance on the use of the module.

40.2.2.1 Determination of maximum power. Maximum power is determined by the worst case operating conditions of the module. Factors influencing power are voltage, frequency, duty cycle, loads, and any other characteristic that produce the highest current. The power for digital modules is to be determined with worst case conditions. The power for analog modules is to be determined with load connected to the output.

40.2.3 Component temperatures. The following requirements for CCT and TCCT apply.

40.2.3.1 CCT. The CCT for semiconductor devices shall be 105°C junction for classes I and III and 130°C junction for classes II and IV. For all other components, the CCT shall be equal to the individual component's maximum specified operating temperature minus 20°C and shall be specified on the component's hottest external area for the thermal interface held at the maximum temperature for the applicable class.

40.2.3.2 TCCT. The TCCT for all devices shall be the appropriate CCT plus 20°C.

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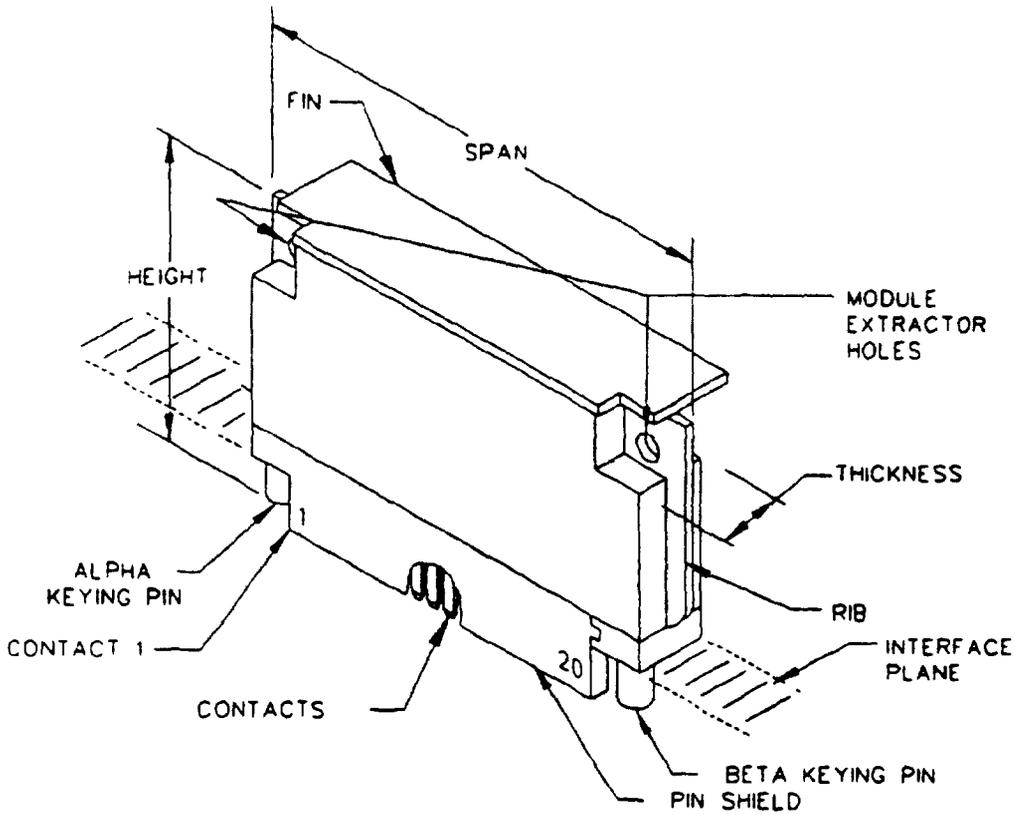


FIGURE 16. Module outline.

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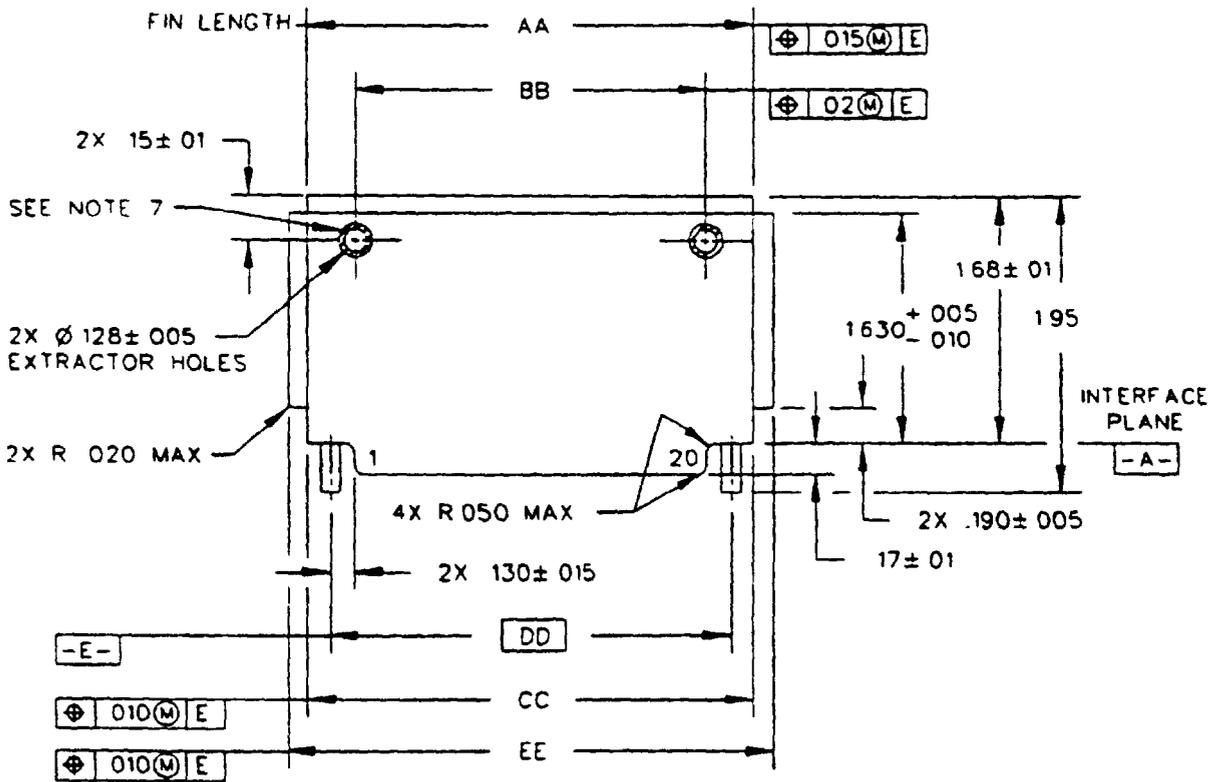


FIGURE 17. Module basic size outline.

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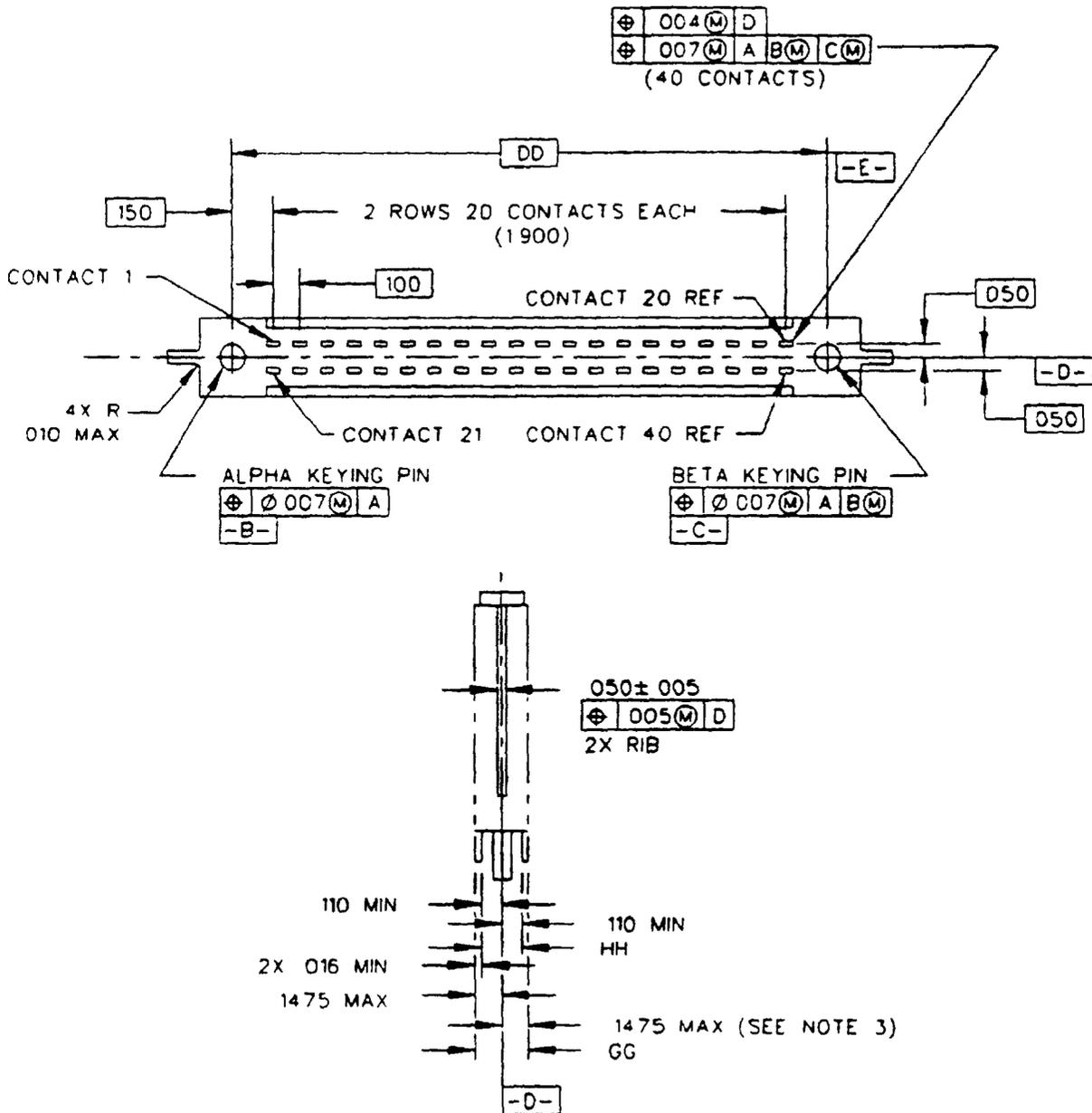


FIGURE 17. Module basic size outline - Continued.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.004	0.102	0.016	0.406	0.130	3.302	1.68	42.67
0.005	0.127	0.02	0.51	0.1475	3.7465	1.900	48.260
0.007	0.178	0.050	1.270	0.15	3.81	1.95	49.53
0.010	0.254	0.100	2.540	0.17	4.32	2.200	55.880
0.01	0.25	0.110	2.794	0.190	4.826		
0.015	0.381	0.128	3.251	1.630	41.402		

NOTES:

1. See table VIII for letter dimensions.
2. The 0.1475 inch (3.7465 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimension GG maximum governs.
3. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
4. Datum plane E is established by the two keying pin features at their virtual condition.
5. Dimensions are in inches.
6. Metric equivalents are given for general information only.
7. Crosshatched area must be free of obstructions for extraction purposes.

FIGURE 17. Module basic size outline - Continued.

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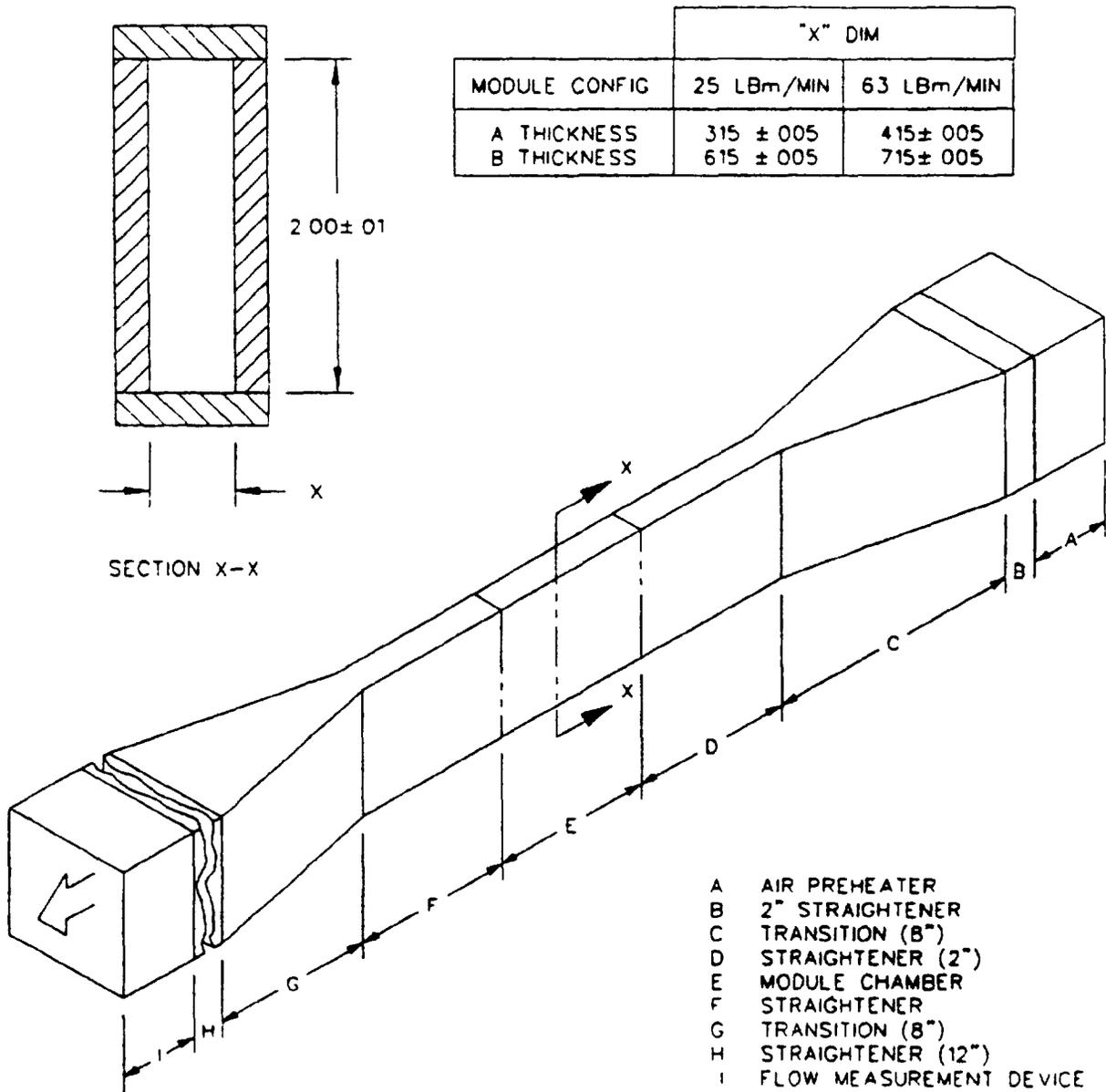


FIGURE 18. Direct air impingement, format B.

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Inches	mm	Inches	mm
0.005	0.127	0.615	15.621
0.01	0.25	0.715	18.161
0.315	8.001	2.000	50.800
0.415	10.541		

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.

FIGURE 18. Direct air impingement, format B - Continued

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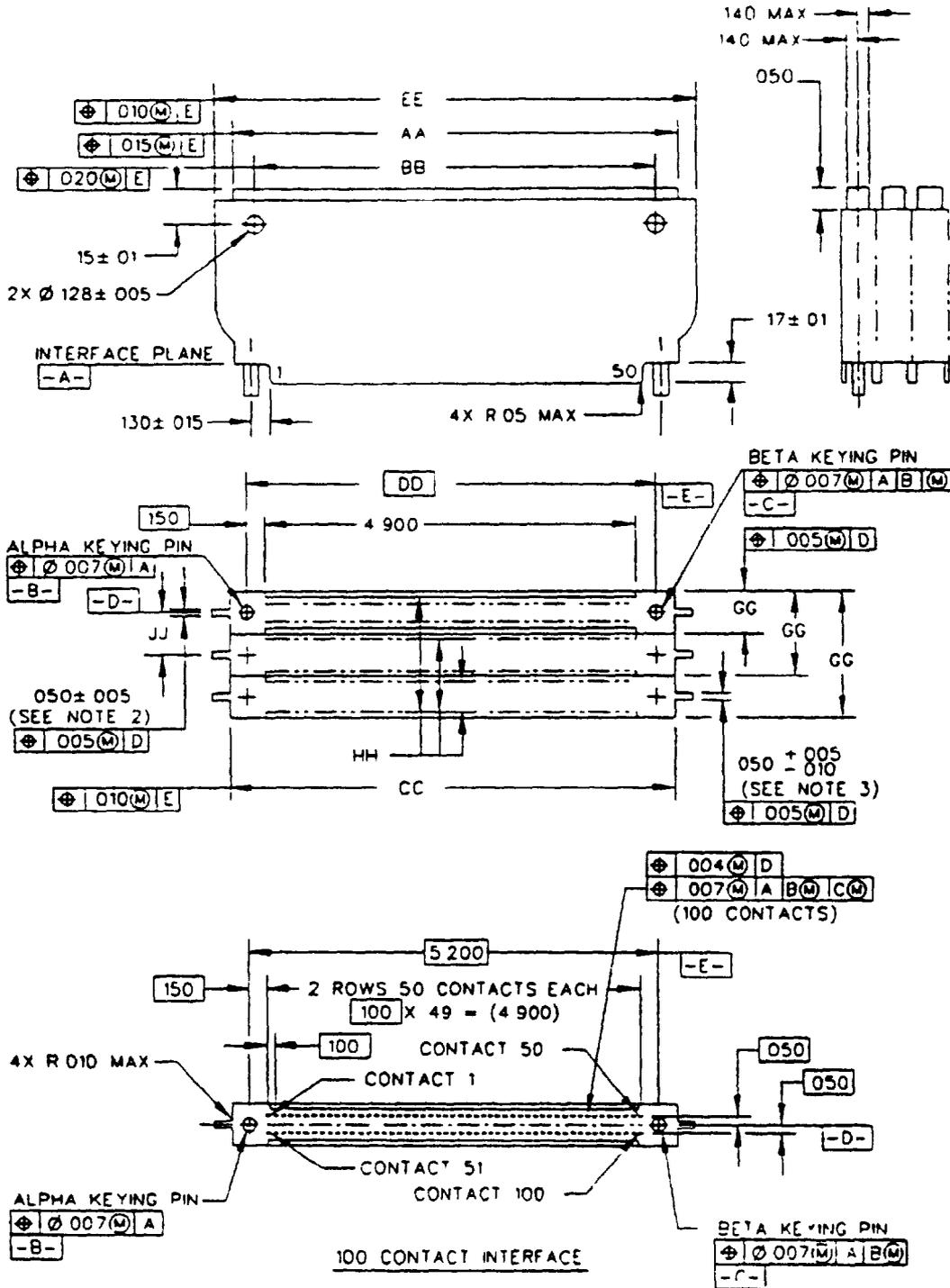


FIGURE 19 Multiple increment module outline

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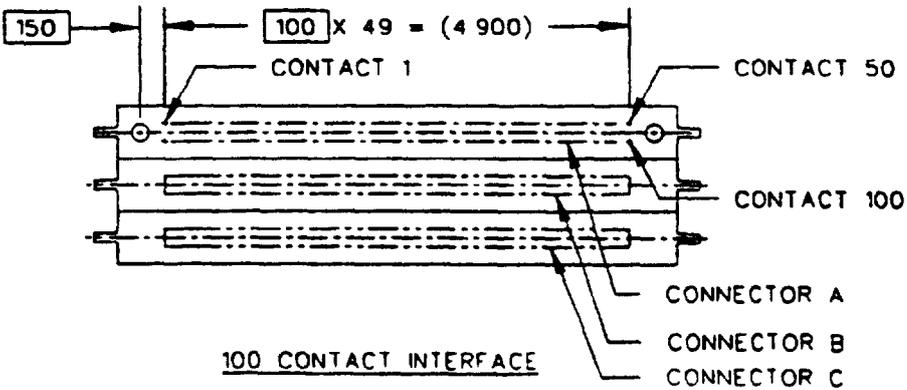
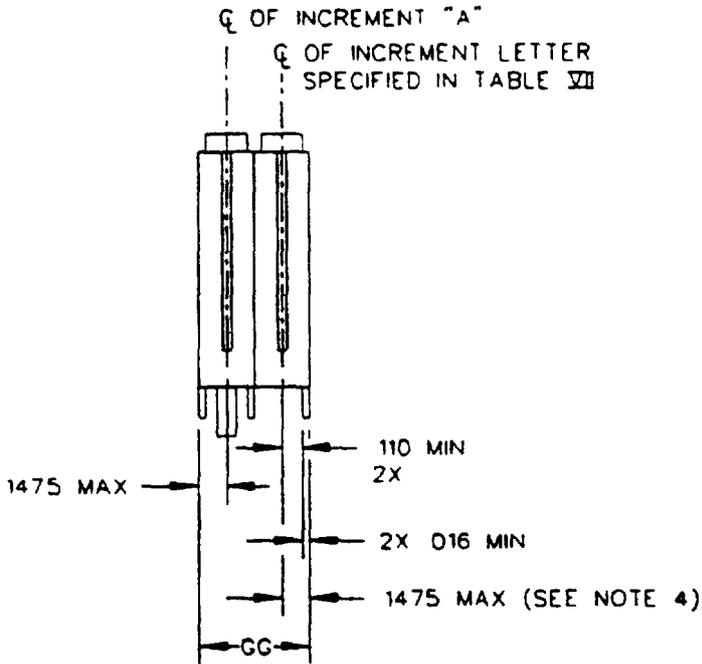


FIGURE 19. Multiple increment module outline - Continued.

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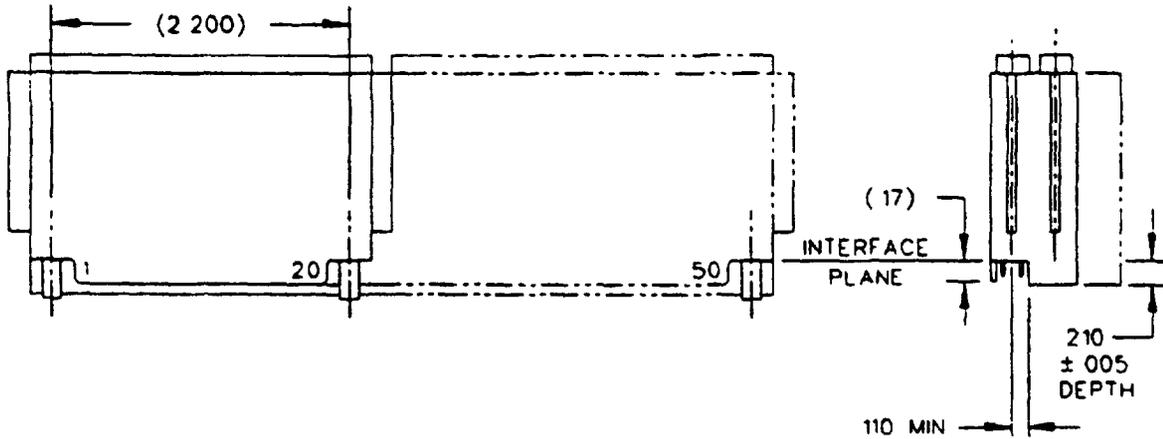
Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.004	0.108	0.016	0.406	0.128	3.251	0.17	4.32
0.005	0.127	0.020	0.508	0.130	3.302	4.900	124.460
0.007	0.178	0.050	1.270	0.140	3.556	5.200	132.080
0.010	0.254	0.05	1.27	0.1475	3.7465		
0.01	0.25	0.100	2.540	0.150	3.810		
0.015	0.381	0.110	2.794	0.15	3.81		

NOTES:

1. Module pin shields are only required for the external protection of contacts and are not required for module increments which do not contain contacts.
2. The 0.050 plus or minus 0.005 inch (1.270 plus or minus 0.127 mm) dimension applies to the first module increment only.
3. The 0.050 plus 0.005, minus 0.010 inch (1.270 plus 0.127, minus 0.254 mm) dimension applies to all module increments except the first.
4. The 0.1475 inch (3.7465 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimension GG maximum governs.
5. See table VIII for letter dimensions.
6. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
7. Datum plane E is established by the two keying pin features at their virtual condition.
8. Dimensions are in inches.
9. Metric equivalents are given for general information only.

FIGURE 19 Multiple increment module outline - Continued.

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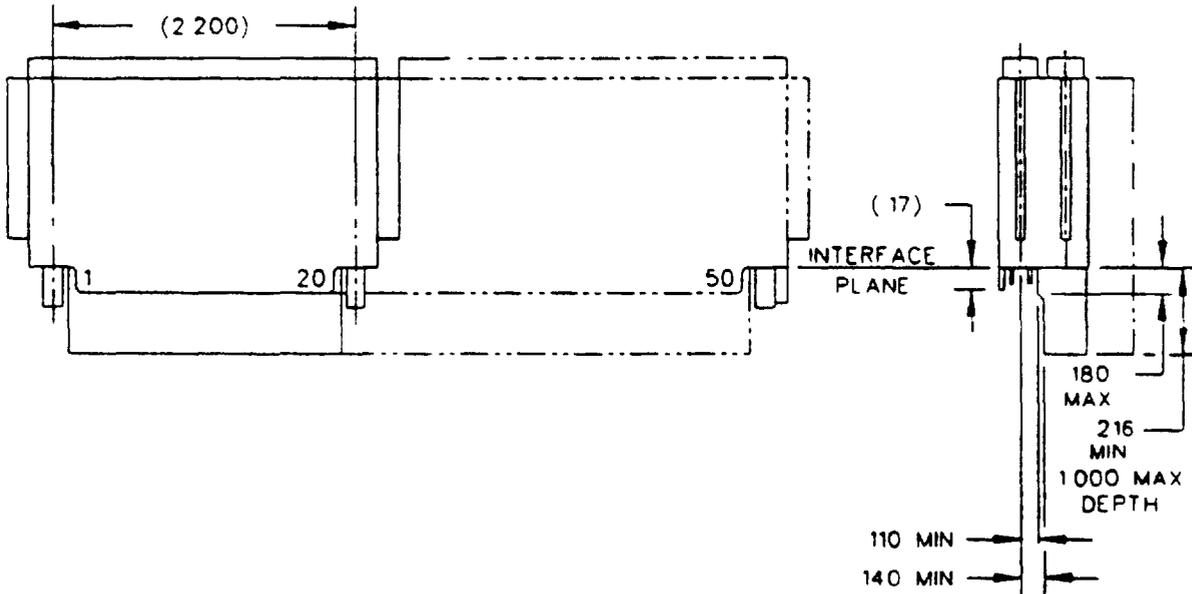
Inches	mm
0.005	0.127
0.110	2.794
0.17	4.32
0.210	5.334
2.200	55.880

NOTES:

1. Modules in this configuration require modification to the mated interface plane (mounting plate).
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.

FIGURE 20 Plate mounted module outline.

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Inches	mm	Inches	mm
0.110	2.794	0.216	5.496
0.140	3.555	1.000	25.400
0.17	4.32	2.200	55.880
0.180	4.572		

NOTES:

1. Modules in this configuration require modification to the mated interface plane (mounting plate).
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.

FIGURE 21. Sub-plate mounted module outline.

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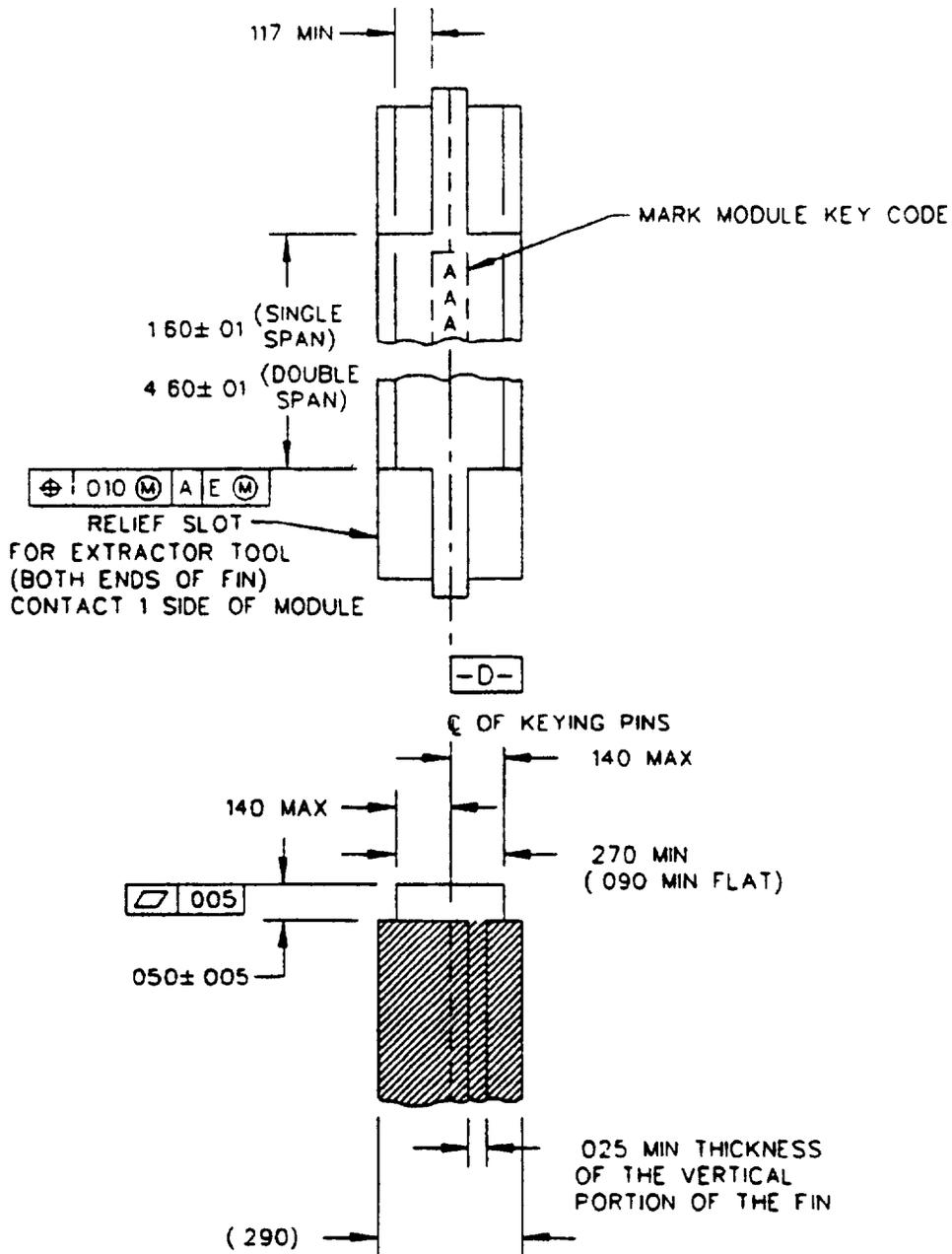


FIGURE 22. Identification, insertion, extractor, and cooling fin outline.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.005	0.127	0.025	0.635	0.117	2.972	0.290	7.366
0.010	0.254	0.050	1.270	0.140	3.556	1.60	40.64
0.01	0.25	0.090	2.286	0.270	6.858	4.60	116.84

NOTES:

1. Location of vertical portion of fin optional within shaded area.
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.

FIGURE 22. Identification, insertion, extractor, and cooling fin outline - Continued.

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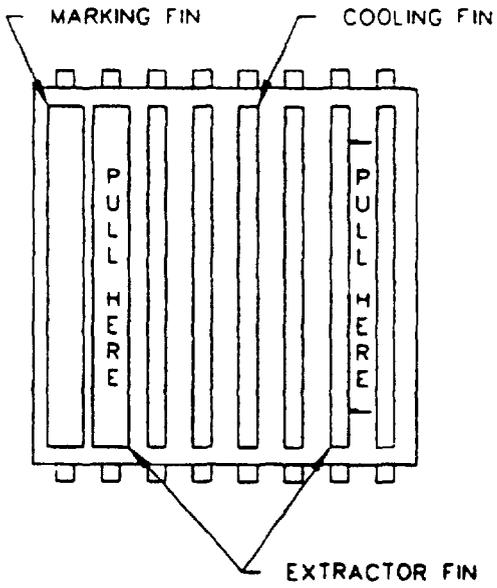


FIGURE 23. Extractor fin identification.

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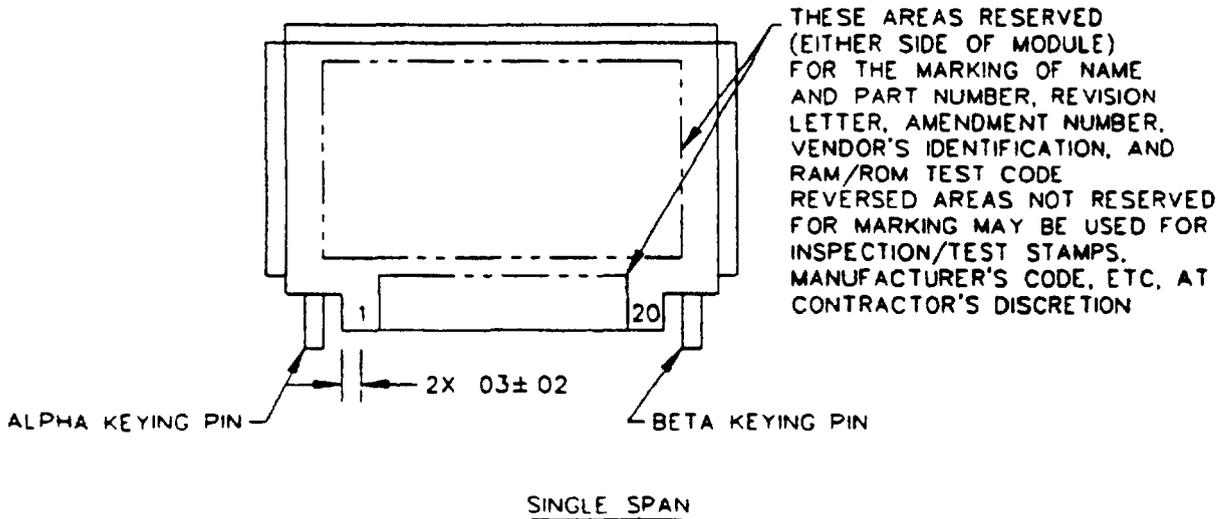
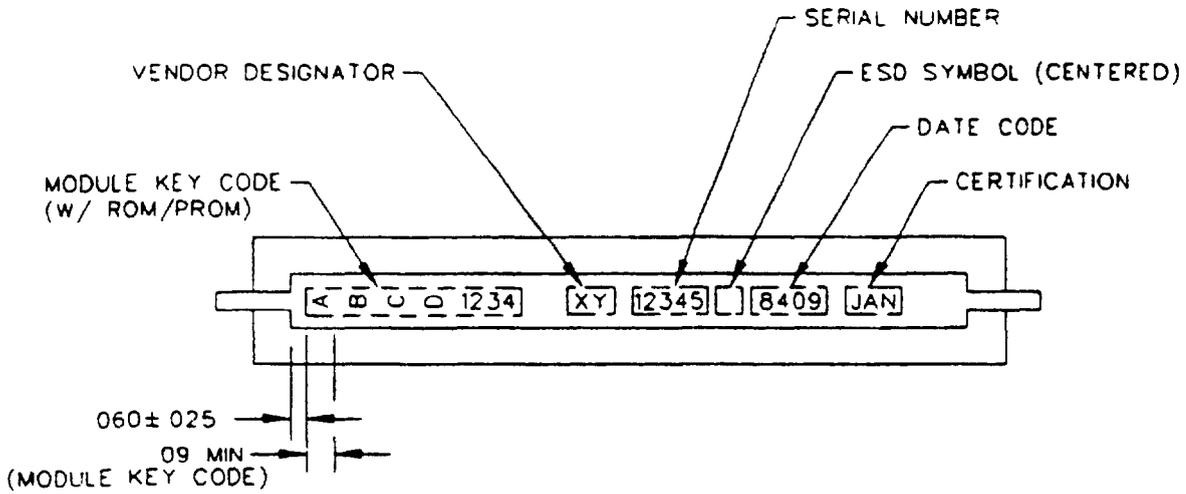
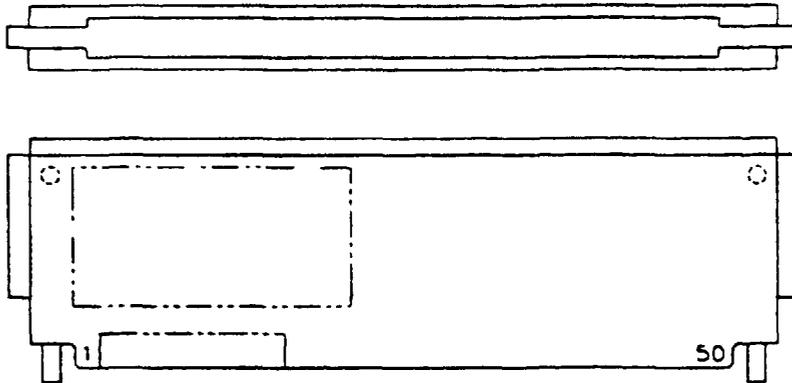


FIGURE 24. Module marking areas.

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MULTIPLE SPAN (SEE NOTE 1)

Inches	mm
0.02	0.51
0.025	0.635
0.03	0.76
0.060	1.524
0.09	2.29

NOTES:

1. All marking performed on a multiple span module shall be the same and located in the same areas as a single span module.
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.
4. Contact the SEM-QAA for direction if insufficient space is available when marking Format B-1A fins.
5. The 0.060 spacing between fin end and the key code shall be measured between the first letter of the key code and that part of the fin nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum.

FIGURE 24. Module marking areas - Continued.

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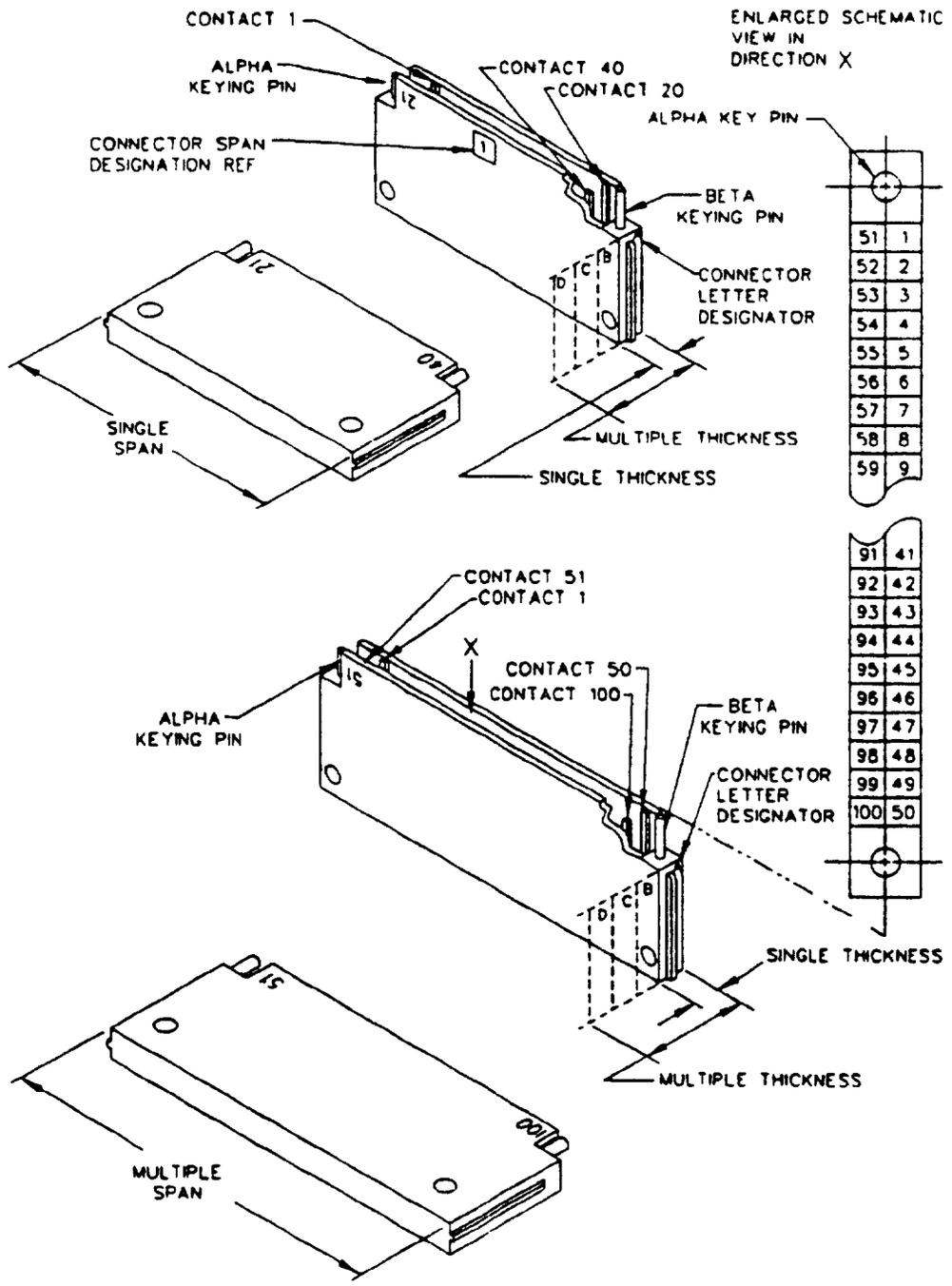


FIGURE 25. Connector contact assignment.

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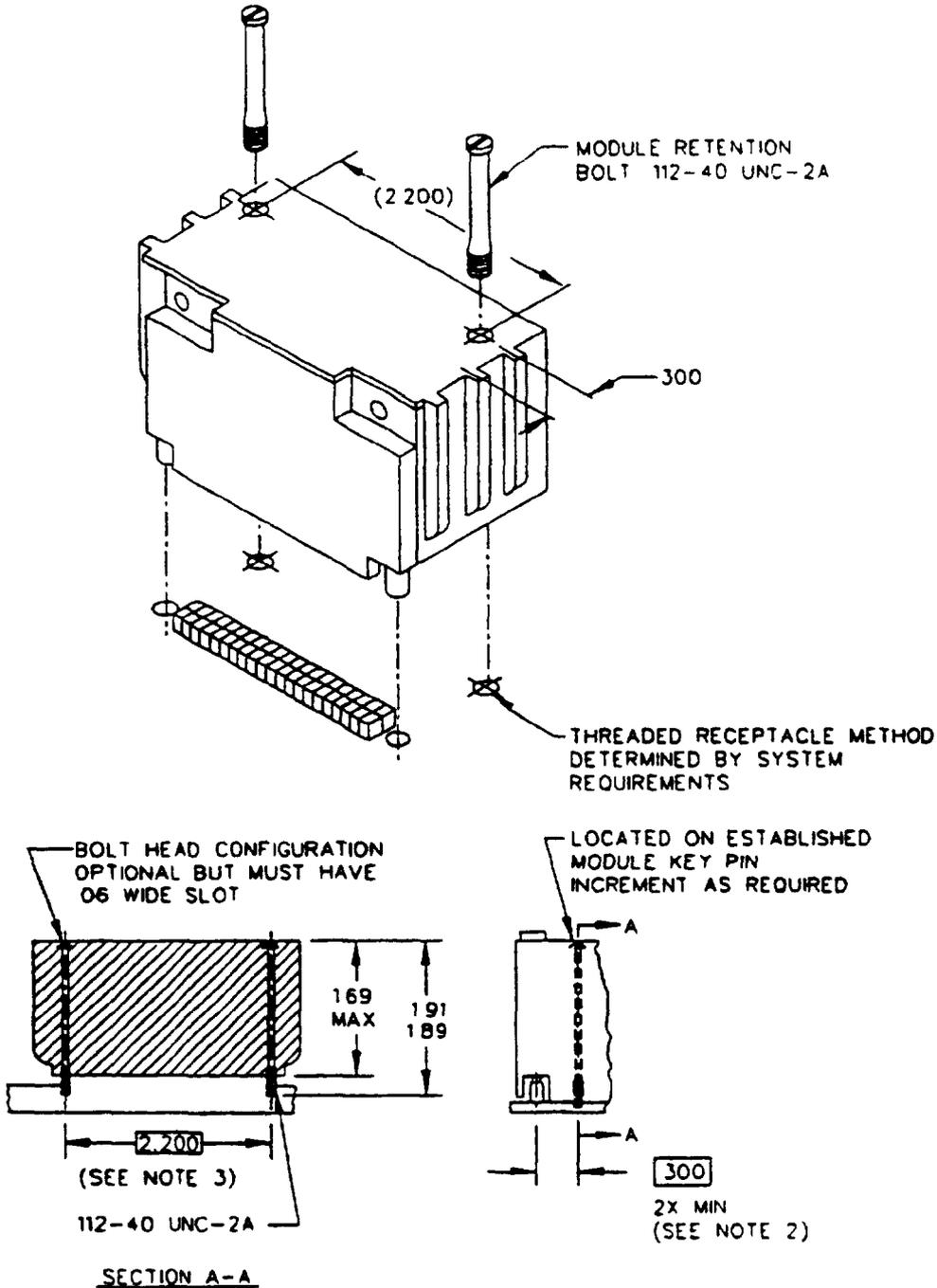


FIGURE 26. Module retention bolt interface.

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Inches	mm
0.06	1.52
0.112	2.845
0.300	7.620
1.69	42.93
1.89	48.01
1.91	48.51
2.200	55.880

NOTES:

1. When holddown bolts are in their secured position, the head of the bolt shall be within the 1.69 inch (42.93 mm) dimension.
2. A minimum of two holddown bolts, when required, shall be provided at both the alpha and beta ends of the module increment in which they are located.
3. Clearance holes 0.142 inch (3.607 mm) diameter minimum $\boxed{\oplus \varnothing 0.10 \text{ (M)} \ominus E}$ (0.254 mm), 2 holes, same distance apart as the keying pins.
4. Dimensions are in inches.
5. Metric equivalents are given for general information only.

FIGURE 26 Module retention bolt interface - Continued

APPENDIX C

DESIGN REQUIREMENTS FOR FORMAT C MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of the standard for the design requirements for format C modules to be used in SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications. The following specification forms 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.

SPECIFICATIONS

MILITARY

MIL-C-26074 - Coatings, Electroless Nickel, Requirements For.

(Unless otherwise indicated, copies of the military specification are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Ave, Philadelphia, PA 19120-5099.)

30. GENERAL REQUIREMENTS

30.1 Mechanical configuration requirements. The basic mechanical configurations are specified on figures 27 and 28 with incremental growth in thickness specified in table IX. Drawing practices shall be in accordance with DOD-STD-100.

30.1.1 Lateral displacement. The module may be designed to provide a lateral displacement between the module frame and connector of plus or minus 0.006 inch (0.152 mm) minimum from the center of the two guide rib profiles. The maximum force required to displace the connector shall be 10 pounds (44.4 newtons). The force shall be applied equally at the points of attachment of the connector to the frame. If the lateral displacement option is exercised, the maximum location of any surface or feature of the connector when the connector is at its extreme displacement shall be in accordance with table IX. The use or non-use of the lateral displacement option shall be stated in the detail specification.

30.2 Thermal requirements. Modules shall be designed to be cooled through the ribs and shall be capable of being cooled by the ribs with no other heat loss.

40. DETAIL REQUIREMENTS

40.1 Configuration. The basic size module has a span of 5.88 inches (149.352 mm), a thickness of 0.280 inch (7.112 mm) and is 4.06 inches (103.12 mm) high including keying pins. Module may increase in thickness in accordance with table IX. Dimensions and tolerances shall be as specified on figure 29.

40.1.1 Circuitry. The module shall have a minimum clearance of 0.015 inch (0.381 mm) around all edges of the substrate or printed-board. The printed-board shall be further reduced to allow for insertion of the module extractor, prevent component damage during module extraction, and to allow for any curvature of the frame from the rib edge to the flat surface.

40.1.2 Module header structure The module header shall perform the following functions:

- (a) Module identification.
- (b) Module insertion and extraction
- (c) Component protection.

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40.1.2.1 Module identification. The module identification header shall have the configuration and marking as specified on figure 30.

40.1.2.2 Module insertion. The header structure shall withstand 100 pounds (445 newtons) of insertion force.

40.1.2.3 Component protection. The header structure shall be designed to help prevent component damage during exposure to insertion and extraction.

40.1.3 Module frame. The module frame shall include module rib structures and extraction capability.

40.1.3.1 Module rib structure. The basic module configuration shall have two ribs; one located at the alpha end, and one located at the beta end of the module (see figure 28).

40.1.3.2 Module extractor interface. Modules shall have a set of two extractor holes located as shown on figure 29.

40.1.4 Module connector. The basic module connector shall have two rows of 50 metal blade type contacts. Modules may increase contact quantity to three, four, and five rows of 50 contacts with all rows of 50 contacts to be complete as specified in table IX. Connectors shall be in accordance with MIL-C-28754 or the requirements specified herein.

40.1.4.1 Connector location. The location of connectors shall be as shown on figure 29. Each connector shall have contacts identified by numbers indicating the first and last contact of the row closest to the pin shield as shown on figure 29.

40.1.4.2 Contact location. The location of contacts shall be as shown on figures 28 and 29.

40.1.4.3 Flexible circuits. A flexible circuit may be utilized as a means of terminating to the module circuitry. This flexible circuit shall meet the requirements of paragraph 5.2.2.3

40.1.5 Module mechanical requirements. The following mechanical requirements apply.

40.1.5.1 Module integrity. Each module, with the connector assembled, shall withstand without damage or separation a minimum axial force normal to the interface plane equal to 100 pounds (445 newtons) on insertion and 4 ounces (1.11 newton) per contact on extraction. The force shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.1.1 Module extractor integrity. The extractor structure shall provide the strength required to extract the module and meet the requirements of 40.1.5.1.

40.1.5.1.2 Module header integrity. The header structure shall provide the strength required to install the module and meet the requirements of 40.1.2.2.

40.1.5.2 Module torque requirements. The module shall withstand the following torque requirements.

40.1.5.2.1 Header torque. The module header shall withstand a 10 inch-pound (1.13 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.2.2 Module torque. The module shall withstand a torque of 25 inch-pounds (2.83 newton-meter) applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.3 Module cantilever load. The module shall withstand a force of 5 pounds (22 newtons). The force shall be applied in two directions and shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.4 Durability. The module shall withstand 500 cycles of mating and unmating with no degradation of module performance. The module shall also withstand 500 cycles of lateral displacement to simulate the use of thermal clamping devices. The clamping testing may be included in the insertion and extraction sequence or completed after the insertion and extraction cycling.

40.1.5.4.1 Clamping durability (floating modules). Modules which exercise the lateral displacement option shall withstand durability clamping by being displaced 0.006 inch (0.152 mm) from both sides of the centerline of the guide rib profiles by uniformly applying a maximum constant force of 10 lbs. (44 N) to each guide rib.

40.1.5.4.2 Clamping durability (nonfloating modules). Modules that do not exercise the lateral displacement option shall withstand durability clamping by being displaced up to 0.0030 plus 0.0005, minus 0.0000 inch (0.0762 plus 0.0127, minus 0.0000 mm) from either side of the centerline of the guide rib profiles by uniformly applying a maximum constant force of 75 pounds (334 newtons) to each guide rib.

40.1.5.5 Keying pin pushout. Each keying pin shall withstand a pushout force of 40 pounds (178 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.6 Finishes and protective treatments. The finish and protective treatment requirements apply.

40.1.6.1 Module surface finish. The surface finish of the module shall be free of any imperfections that have a detrimental effect upon the performance of the module. The surface finish of the ribs shall be 25 microinch (0.00064 mm) or better.

40.1.6.2 Copper and copper composite frame plating. Copper and copper composite frames shall be electroless nickel plated in accordance with MIL-C-26074, class 1, grade A.

40.1.6.3 Aluminum frame plating. Aluminum frames shall receive an anodic treatment in accordance with MIL-A-8625, type III, class 2, black.

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40.1 6 4 Connector body plating Any aluminum parts utilized on the connector shall receive an anodic treatment in accordance with MIL-A-8625, type III, class 2, black

40 1 7 Test points The module design may provide for test points

40.1 7 1 Acceptance testing. Final electrical acceptance testing shall be performed through the input/output connector contacts on the module.

40.1 7.2 Fault isolation testing For the purpose of component fault isolation testing, test points may be used in addition to the input/output connector contacts on the module. The following design and usage rules shall apply:

- (a) Any output may be accessed.
- (b) Only those inputs which will not effect timing requirements of module operation shall be accessed.
- (c) Physical breaking of the module signal paths through test points shall not be allowed

40.2 Thermal requirements The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that CCTs are not exceeded when modules are operated at typical power at the maximum thermal interface temperature for the appropriate class.

40.2.2 Typical power dissipation Typical power dissipation means the maximum recommended power dissipation under nominal module operating conditions. Typical power values for semiconductor devices are derived from contractor developed characterization data (if available) or secondly, from vendor data sheets. When the typical power dissipation for a component cannot be determined, the maximum power dissipation for worst case module operating conditions shall be used

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40.2.3 Recommended module power dissipation. The maximum recommended module power dissipation is 18 watts under typical operating conditions. Detail module specifications covering any module design dissipating greater than the above recommended value shall have the method of cooling specified for future application guidance on the use of the module.

40.2.4 Component temperatures. The following requirements for CCT and TCCT apply.

40.2.4.1 CCT. The CCT for semiconductor devices dissipating 2.5 watts or less typical power shall be 85°C junction for classes I and III and 110°C junction for classes II and IV. For semiconductors dissipating more than 2.5 watts typical power, the CCT may increase 15°C per watt or a maximum of 15°C above that specified for 2.5 watt or less devices. For all other components, the CCT shall be equal to the individual components maximum specified operating temperature minus 30°C and shall be specified on the component's hottest external area. Where components do not meet the CCT requirements, but do not exceed 105°C for classes I and III, the module shall be considered acceptable if the calculated MTBF is greater than 50,000 hours. In no case shall a component have its maximum rated junction temperature exceeded.

40.2.4.2 TCCT. The TCCT for all devices shall be the appropriate CCT plus 20°C.

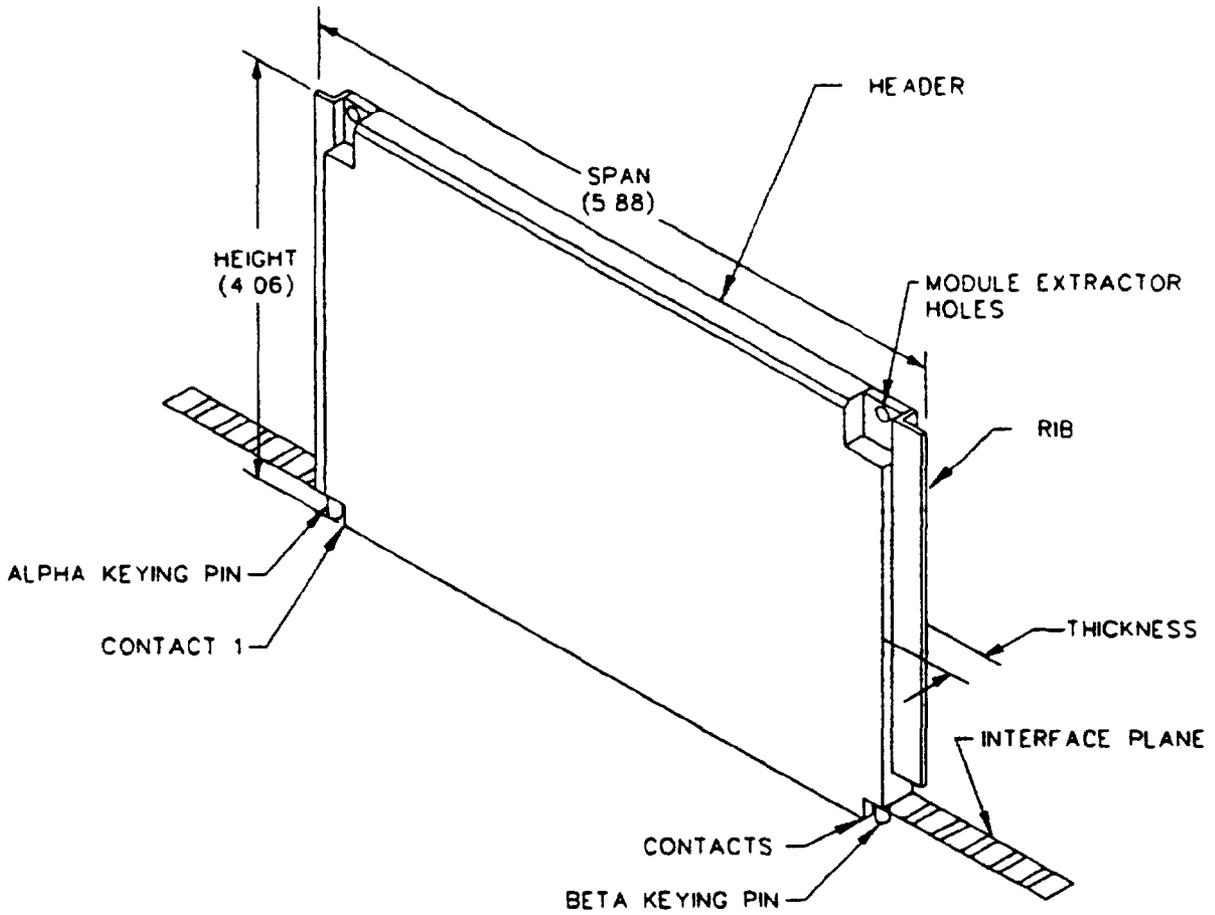
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TABLE IX. Module growth. 3/ 4/

Thickness	A	B	C	D
Module pitch 1/	0.3 (7.6 mm)	0.4 (10.2 mm)	0.5 (12.7 mm)	0.6 (15.2 mm)
Maximum module thickness, GG	0.280 (7.112 mm)	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum connector profile, HH + 0.140 max	0.280 (7.112 mm)	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum number of contacts	100	150	200	250
Dimension NN (max) 2/ (see figure 28)	0.152 (3.861 mm)	0.202 (5.131 mm)	0.252 (6.401 mm)	0.302 (7.671 mm)
Dimension YY (max) 2/ (see figure 28)	0.152 (3.861 mm)	0.202 (5.131 mm)	0.252 (6.401 mm)	0.302 (7.671 mm)
Dimension RR (max) (keying pin to guide ribs; see figure 29)	0.000 (.000 mm)	0.050 (1.270 mm)	0.100 (2.540 mm)	0.150 (3.810 mm)
Dimension BB (max) (see figure 29)	0.140 (3.556 mm)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.176 mm)
Dimension HH (max) (see figure 29)	0.140 (3.556 mm)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.176 mm)

- 1/ Pitch refers to the distance between module centerlines for system packaging purposes
- 2/ The dimensions are from the center of the two basic guide rib profiles to locate connector lateral extreme displacement
- 3/ Dimensions are in inches.
- 4/ Metric equivalents are given for general information only.

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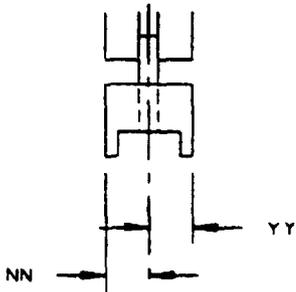
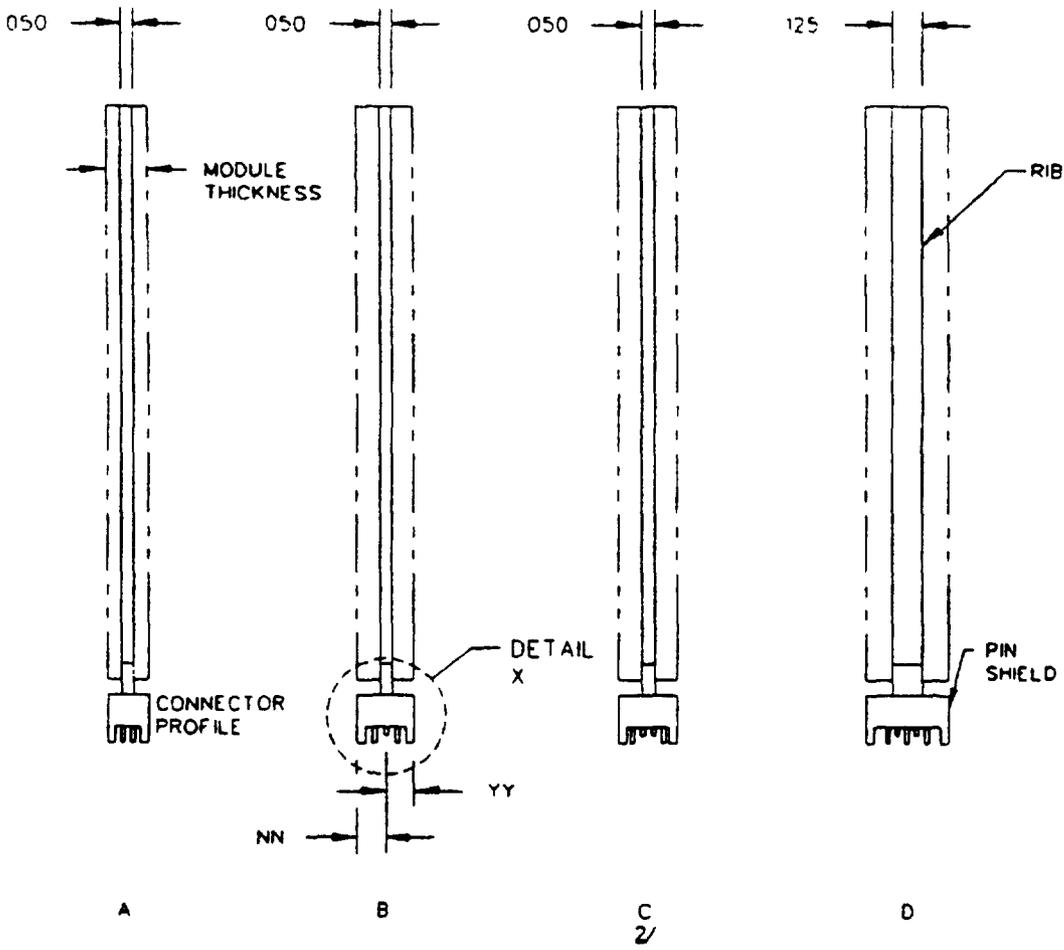
Inches	mm
4.06	103.12
5.88	149.35

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 27. Module outline.

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DETAIL X 1/2

FIGURE 28. Module configurations - side view.

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- 1/ Contacts deleted for clarity.
- 2/ On 200 contact configuration, the contact stagger shown may be reversed with the shorter contacts being nearest the pin shields.

FIGURE 28. Module configurations - side view - Continued.

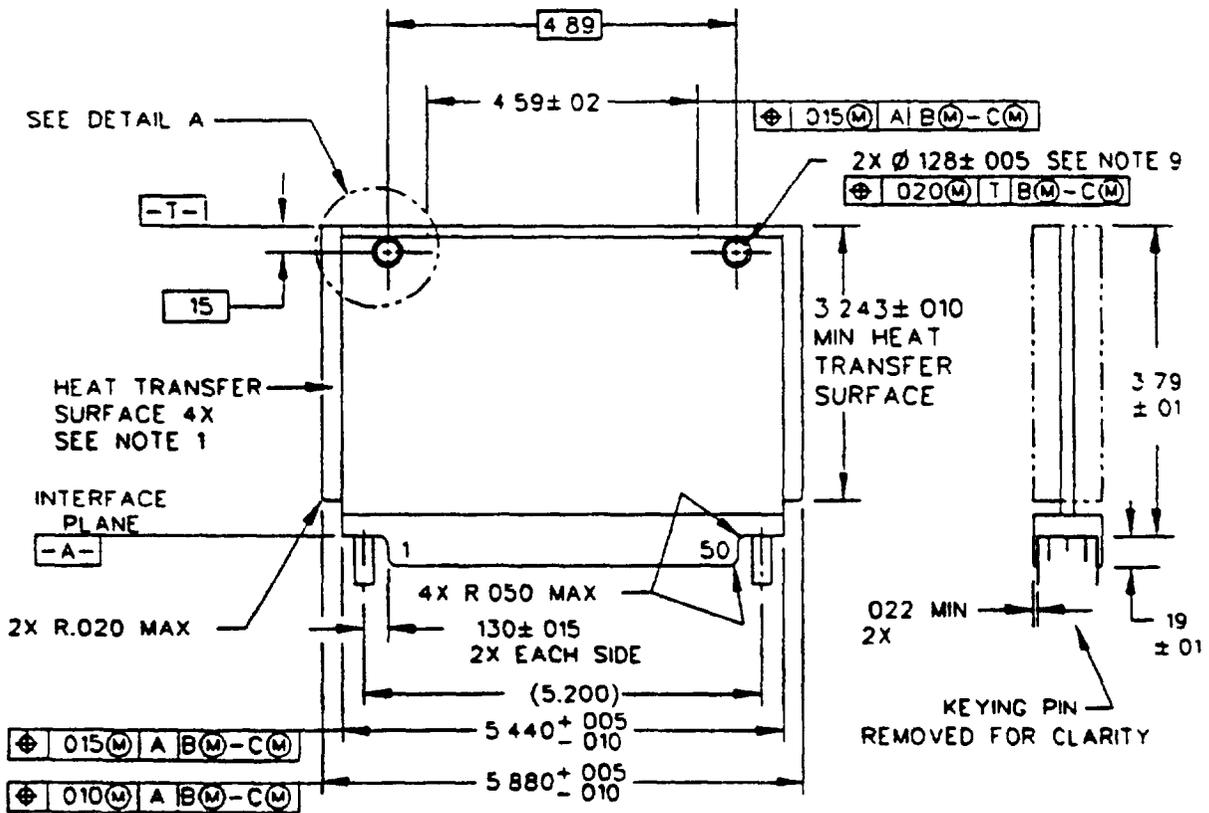


FIGURE 29. Module configurations.

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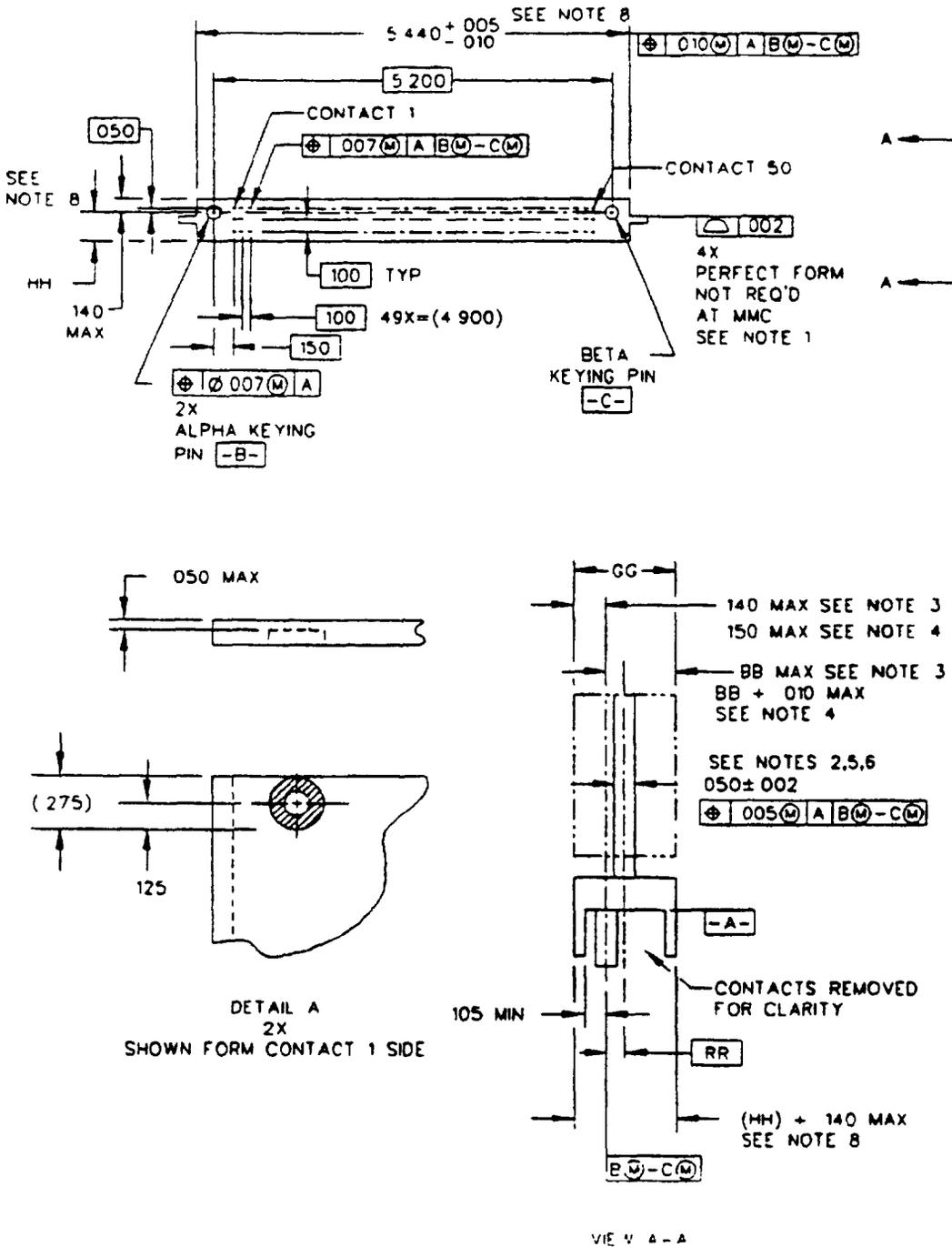


FIGURE 29. Module configurations - Continued.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.002	0.051	0.02	0.51	0.125	3.175	0.19	4.83	4.59	116.59
0.005	0.127	0.020	0.508	0.128	3.251	0.275	6.985	4.89	124.21
0.007	0.178	0.022	0.559	0.130	3.302	0.40	10.16	5.200	132.080
0.010	0.254	0.050	1.270	0.140	3.556	3.243	82.372	5.440	138.176
0.01	0.25	0.100	2.540	0.150	3.810	3.79	96.27	5.880	149.352
0.015	0.381	0.105	2.667						

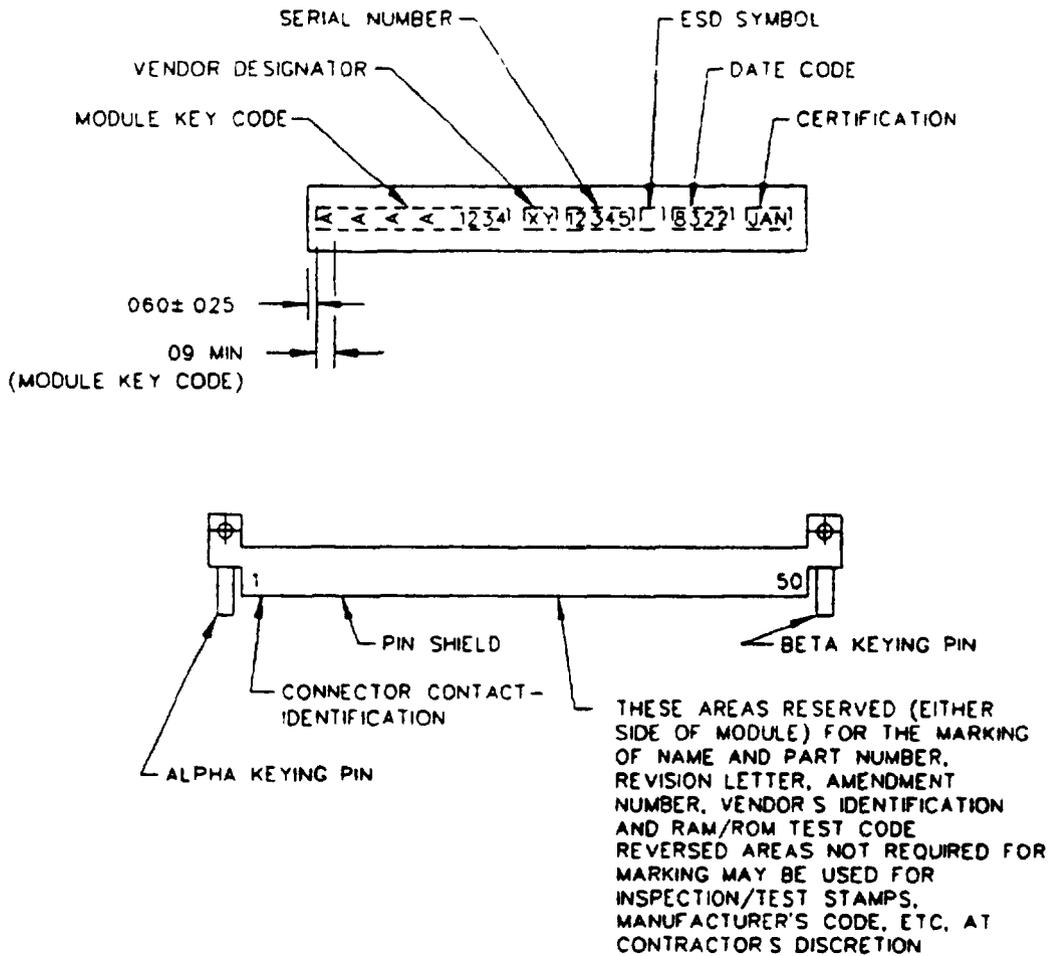
NOTES:

1. The heat transfer surface of the guide rib is defined by the 0.220 inch (5.588 mm) nominal by 3.243 inch nominal area of the frame on both ends. Both sides of each guide rib (4 surfaces total) shall have a surface finish of 25 microinch (0.00064 mm) or better, and coplanar surfaces shall have a profile of 0.002 inch. The end of each guide rib (0.050 inch by 3.470 inch) is not required to meet the surface finish requirements of the heat transfer surface.
2. The guide rib feature shall be contained within a 0.059 (1.499 mm) max zone for 0.3, 0.4 and 0.5 pitch. The feature shall be contained within a 0.129 (3.276 mm) maximum zone for 0.6 pitch modules (rib thickness 0.125 plus or minus 0.002).
3. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
4. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does have lateral translation (floating).
5. Modules employing the lateral displacement option (float) shall maintain the position of the guide ribs with respect to the connector datum (B-C) to the same tolerance as modules without the lateral displacement (nonfloat). The floating module will be allowed to be translated into position to meet this requirement. This requirement shall not alter the requirements of 30.1.1. The requirements of 30.1.1 shall be verified by a separate test.
6. These dimensions are applicable for locating the profile of the module guide rib with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
7. The GG maximum dimension applies to the module component profile.
8. These dimensions apply to the connector profile (see table IX).
9. Crosshatched area to be free of construction for extraction.
10. Dimensions are in inches.
11. Metric equivalents are given for general information only
12. 150 contact connector shown as an example.

FIGURE 29. Module configurations - Continued

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Inches	mm
0.025	0.635
0.060	1.524
0.09	2.29

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The 0.060 spacing between fin end and the module key code shall be measured between the first letter of the key code and that part of the fin nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum.

FIGURE 30. Module marking areas.

APPENDIX D

DESIGN REQUIREMENTS FOR FORMAT D MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of the standard for the design requirements for format D modules to be used in SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. GENERAL REQUIREMENTS

30.1 Mechanical configuration requirements. The basic mechanical configurations are specified on figures 31 and 32 with incremental growth in thickness specified in table X. Drawing practices shall be in accordance with DOD-STD-100.

30.1.1 Lateral displacement. The module may be designed to provide a lateral displacement between the module frame and connector of plus or minus 0.006 inch (0.152 mm) minimum from the center of the two guide rib profiles. The maximum force required to displace the connector shall be 10 pounds (44.4 newtons). The force shall be applied equally at the points of attachment of the connector to the frame. If the lateral displacement option is exercised, the maximum location of any surface or feature of the connector when the connector is at its extreme displacement shall be in accordance with table X. The use or non-use of the lateral displacement option shall be stated in the detail specification.

30.2 Thermal requirements. Modules shall be designed to be cooled through the ribs and shall be cooled by the ribs with no other heat loss. Modules shall be designed for direct air impingement cooling over the components, and in addition, shall meet the rib cooling design requirements. The cooling design for direct air impingement shall be predicated upon a maximum airflow rate of 0.25 pound mass per minute (0.002

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TABLE X. Module growth. 3/ 4/

Thickness	A	B	C	D
Module pitch 1/	0.3 (7.6 mm)	0.4 (10.2 mm)	0.5 (12.7 mm)	0.6 (15.2 mm)
Maximum module thickness, GG	0.280 (7.112 mm)	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum connector profile, HH + 0.140 max	0.280 (7.112 mm)	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum number of contacts	100	150	200	250
Dimension NN (max) 2/ (see figure 32)	0.152 (3.861 mm)	0.202 (6.401 mm)	0.152 (3.861 mm)	0.152 (3.861 mm)
Dimension YY (max) 2/ (see figure 32)	0.152 (3.861 mm)	0.202 (6.401 mm)	0.352 (8.941 mm)	0.452 (11.481 mm)
Dimension RR (max) Keying pin to guide rib. (see figure 34)	0.000 (.00 mm)	0.050 (1.270 mm)	0.000 (.00 mm)	0.000 (.00 mm)
Dimension BB (max) (see figure 34)	0.140 (3.556 mm)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.176 mm)
Dimension HH (max) (see figure 34)	0.140 (3.556 mm)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.196 mm)

- 1/ Pitch refers to the distance between module centerlines for system packaging purposes.
- 2/ The dimensions are from the center of the two basic guide rib profiles to locate connector lateral extreme displacement
- 3/ Dimensions are in inches.
- 4/ Metric equivalents are given for general information only

kilogram per second) at the inlet air temperature in accordance with the appropriate module class interface temperature for the A incremental thickness when tested in a duct size of 5.43 inches (137.92 mm) high and 0.315 inch (8.001 mm) wide (see figure 33). A maximum airflow rate of 0.63 pound mass per minute (0.005 kilogram per second) for the A incremental thickness module shall be used when tested in a duct size of 5.43 inches (137.92 mm) high and 0.415 inch (10.541 mm) wide. Duct width shall be increased by 0.100 inch (2.540 mm) for each additional module thickness increment. For direct air impingement cooling, the maximum allowable static pressure loss shall be 0.30 inch (7.62 mm) of water.

40. DETAIL REQUIREMENTS

40.1 Configuration. The basic size module has a span of 5.88 inches (149.35 mm), a thickness of 0.280 inch (7.112 mm) and is 4.83 inches (122.68 mm) high including keying pins. Module may increase in thickness in accordance with table X. Dimensions and tolerances shall be as specified on figure 34.

40.1.1 Circuitry. The module shall have a minimum clearance of 0.015 inch (0.381 mm) around all edges of the substrate or printed-board. The printed-board shall be further reduced to allow for insertion of the module extractor, prevent component damage during module extraction, and to allow for any curvature of the frame from the rib edge to the flat surface.

40.1.2 Module header structure. The module header shall perform the following functions:

- (a) Module identification.
- (b) Module insertion and extraction.
- (c) Component protection.

40.1.2.1 Module identification. The module identification header shall have the configuration and marking as specified on figure 35.

40.1.2.2 Module insertion. The header structure shall withstand 100 pounds (445 newtons) of insertion force.

40.1.2.3 Component protection. The header structure shall be designed to help prevent component damage during exposure to insertion and extraction

40.1.3 Module frame. The module frame shall include module rib structures and extraction capability.

40.1.3.1 Module rib structure The basic module configuration shall have two ribs; one located at the alpha end, and one located at the beta end of the module (see figure 32).

40.1.3.2 Module extractor interface. Modules shall have two extractor holes located as shown on figure 34. Modules having a thickness of 2.090 inches (53.086 mm) or greater shall have two sets of extractor holes. The second set shall be located within the last 0.3 inch (7.6 mm) of the module and meet the location requirements shown on figure 34.

40.1.4 Module connector. The basic module connector shall have two rows of 50 metal blade type contacts. Modules may increase contact quantity to three, four, and five rows of 50 contacts with all rows of 50 contacts to be complete as specified in table X. All connectors shall be in accordance with MIL-C-28754 and conform to the requirements specified herein.

40.1.4.1 Connector location. The location of connectors shall be as shown on figure 34. Each connector shall have contacts identified by numbers indicating the first and last contact of the row closest to the pin shield as shown on figures 32 and 34.

40.1.4.2 Contact location The location of contacts shall be as shown on figures 32 and 34.

40.1.4.3 Flexible circuits. A flexible circuit may be utilized as a means of terminating to the module circuitry. This flexible circuit shall meet the requirements of 5.2.2.3.

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40.1.5 Module mechanical requirements. The following mechanical requirements apply.

40.1.5.1 Module integrity. Each module, with the connector assembled, shall withstand without damage or separation a minimum axial force normal to the interface plane equal to 100 pounds (445 newtons) on insertion and 4 ounces (1.11 newton) per contact on extraction. The total computed force shall be applied to the module to simulate module insertion and extraction. The force shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.1.1 Module extractor integrity. The extractor structure shall provide the strength required to extract the module and meet the requirements of 40.1.5.1.

40.1.5.1.2 Module header integrity. The header structure shall provide the strength required to install the module and meet the requirements of 40.1.2.2.

40.1.5.2 Module torque requirements. The module shall withstand the following torque requirements.

40.1.5.2.1 Header torque. The module header shall withstand a 10 inch-pound (1.14 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.2.2 Module torque. The module shall withstand a torque of 25 inch-pounds (2.83 newton-meter) applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.3 Module cantilever load. The module shall withstand a force of 5 pounds (22 newtons). The force shall be applied in two directions and shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

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40.1.5.4 Durability. The module shall withstand 500 cycles of mating and unmating with no degradation of module performance. The module shall also withstand 500 cycles of lateral displacement to simulate the use of thermal clamping devices. The clamping testing may be included in the insertion and extraction sequence or completed after the insertion and extraction cycling. Testing shall conform to the following paragraphs.

40.1.5.4.1 Clamping durability (floating modules). Modules which exercise the lateral displacement option shall demonstrate the ability to withstand clamping durability by being displaced 0.006 inch (0.152 mm) from both sides of the centerline of the guide rib profiles.

40.1.5.4.2 Clamping durability (nonfloating modules). Modules that do not exercise the lateral displacement option shall demonstrate the ability to withstand durability clamping by being displaced up to 0.0030 plus 0.0005, minus 0.0000 inch (0.0762 plus 0.0127, minus 0.0000 mm) from either side of the centerline of the guide rib profiles by uniformly applying a constant force of 75 pounds (334 newtons) to each guide rib.

40.1.5.5 Keying pin pushout. Each keying pin shall withstand a pushout force of 40 pounds (178 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.6 Finishes and protective treatments. The following finish and protective treatment requirements apply.

40.1.6.1 Module surface finish. The surface finish of the module shall be free of any imperfections that have a detrimental effect upon the performance of the module. The surface finish of the ribs shall be 25 microinch (0.00064 mm) or better.

40.1.6.2 Copper and copper composite frame plating. Copper and copper composite frames shall be electroless nickel plated in accordance with MIL-C-26074, class 1, grade A.

40.1.6.3 Aluminum frame plating. Aluminum frames shall receive an anodic treatment in accordance with MIL-A-8625, type III class 2, black

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40.1.6.4 Connector body plating. Any aluminum parts utilized on the connector shall receive an anodic treatment in accordance with MIL-A-8625, type III, class 2, black.

40.1.7 Test points. The module design may provide for test points.

40.1.7.1 Acceptance testing. All final electrical acceptance testing shall be performed through the input/output connector contacts on the module.

40.1.7.2 Fault isolation testing. For the purpose of component fault isolation testing, test points may be used in addition to the input/output connector contacts on the module. The following design and usage rules shall apply:

- (a) Any output may be accessed.
- (b) Only those inputs which will not effect timing requirements of module operation shall be accessed.
- (c) Physical breaking of the module signal paths through test points shall not be allowed.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that CCTs are not exceeded when modules are operated at typical power at the maximum thermal interface temperature for the appropriate class.

40.2.2 Typical power dissipation. Typical power dissipation means the maximum recommended power dissipation under nominal module operating conditions. Typical power values for semiconductor devices are derived from contractor developed characterization data (if available) or secondly from vendor data sheets. When typical power dissipation for a component cannot be determined, the maximum power dissipation for worse case module operating conditions shall be used. Detail specifications covering any

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module design dissipating greater than the above recommended value shall have the method of cooling specified therein for future application guidance on the use of the module.

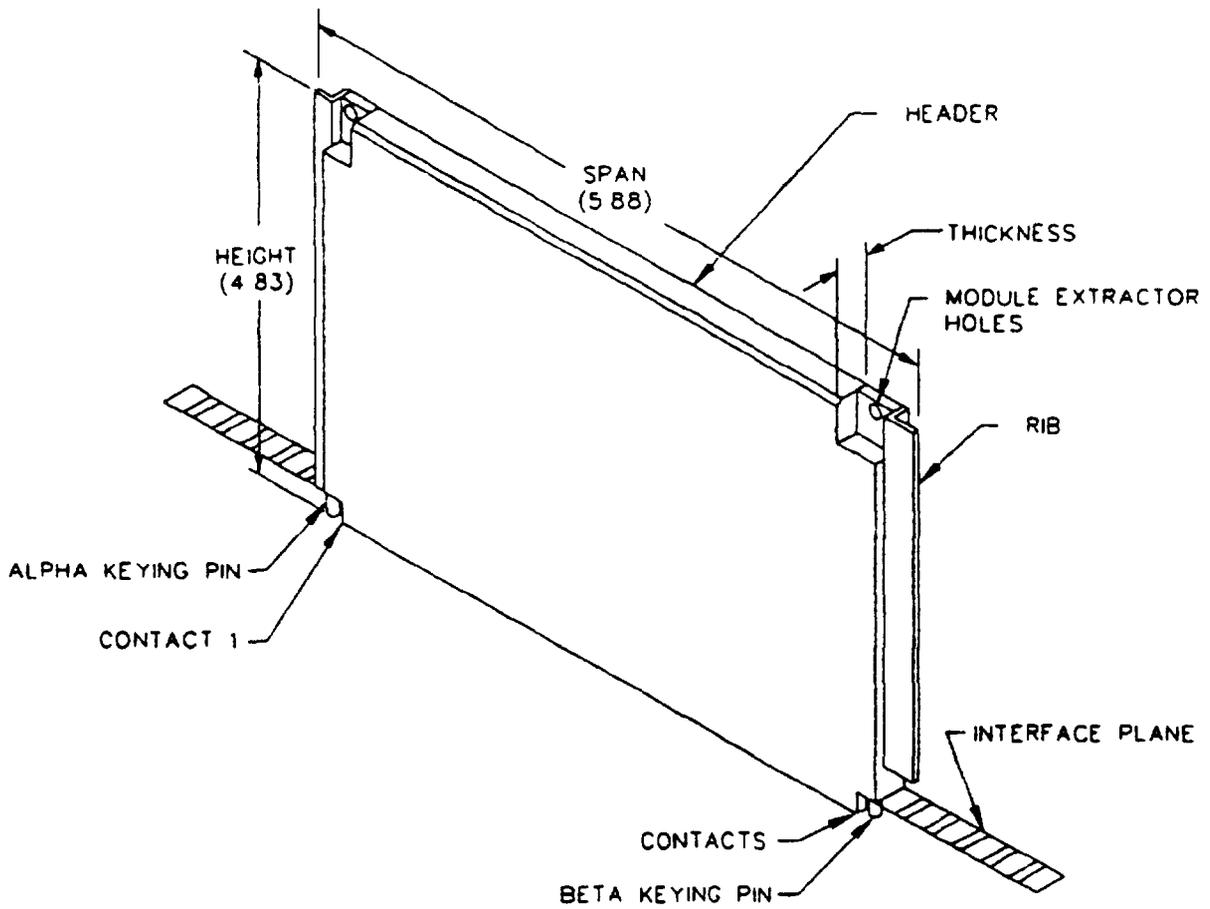
40.2.3 Recommended module power dissipation. The maximum recommended module power dissipation is 26 watts under typical operating conditions. Detail module specifications covering any module design dissipating greater than the above recommended value shall have the method of cooling specified for future application guidance on the use of the module.

40.2.4 Component temperatures. The following requirements for CCT and TCCT apply.

40.2.4.1 CCT. The CCT for semiconductor devices dissipating 2.5 watts or less typical power shall be 90°C junction for classes I and III and 115°C junction for classes II and IV. For semiconductors dissipating more than 2.5 watts typical power, the CCT may increase 15°C per watt or a maximum of 15°C above that specified for 2.5 watt or less devices. For all other components, the CCT shall be equal to the individual component's maximum specified operating temperature minus 30°C and shall be specified on the component's hottest external area. Where components do not meet the CCT requirements, but do not exceed 105°C for class I and III, the module shall be considered acceptable if the calculated MTBF is greater than 50,000 hours. In no case shall a component have its maximum rated junction temperature exceeded.

40.2.4.2 TCCT. The TCCT for all devices shall be the appropriate CCT plus 20°C.

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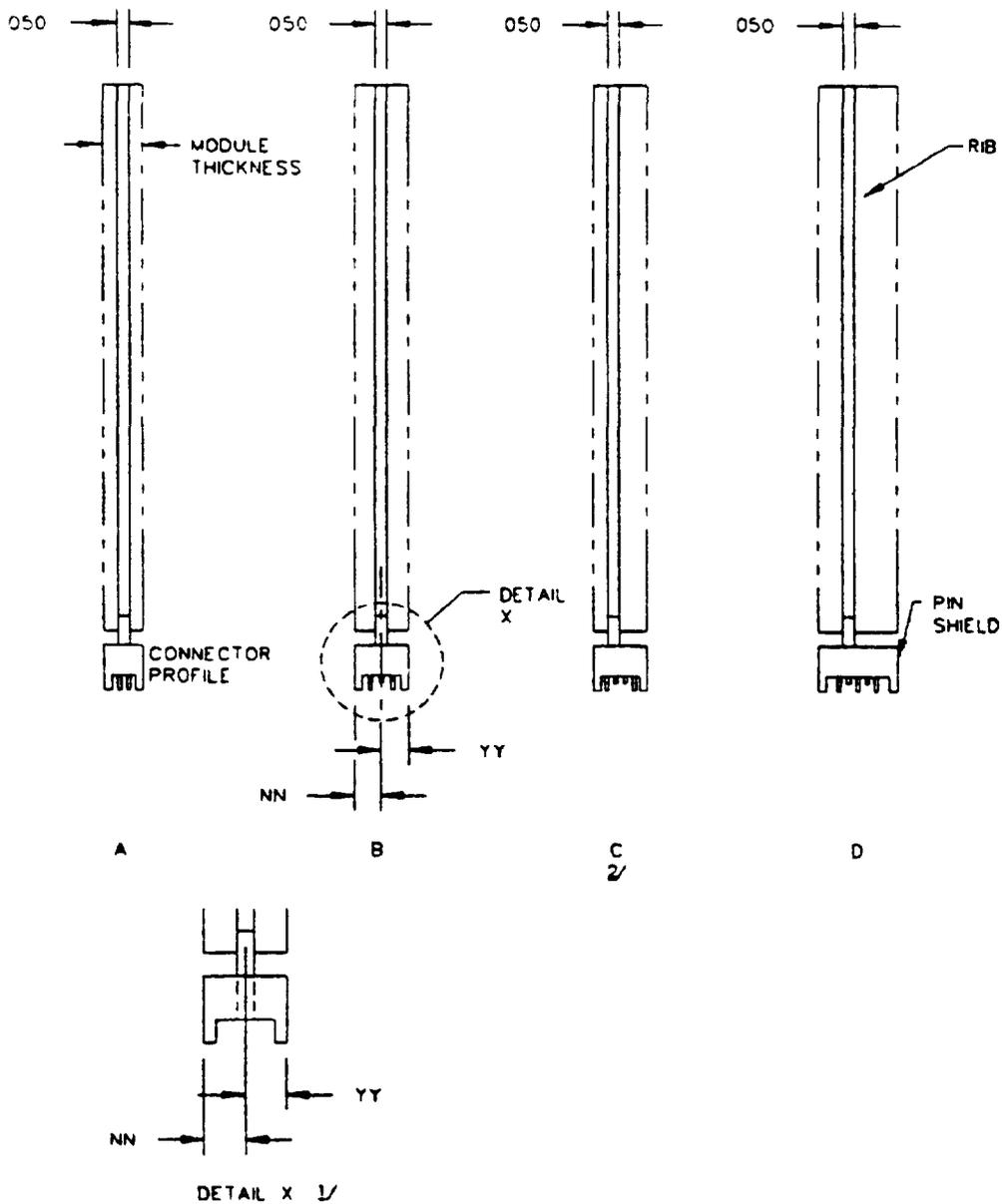
Inches	mm
4.83	122.68
5.88	149.35

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 31. Module outline

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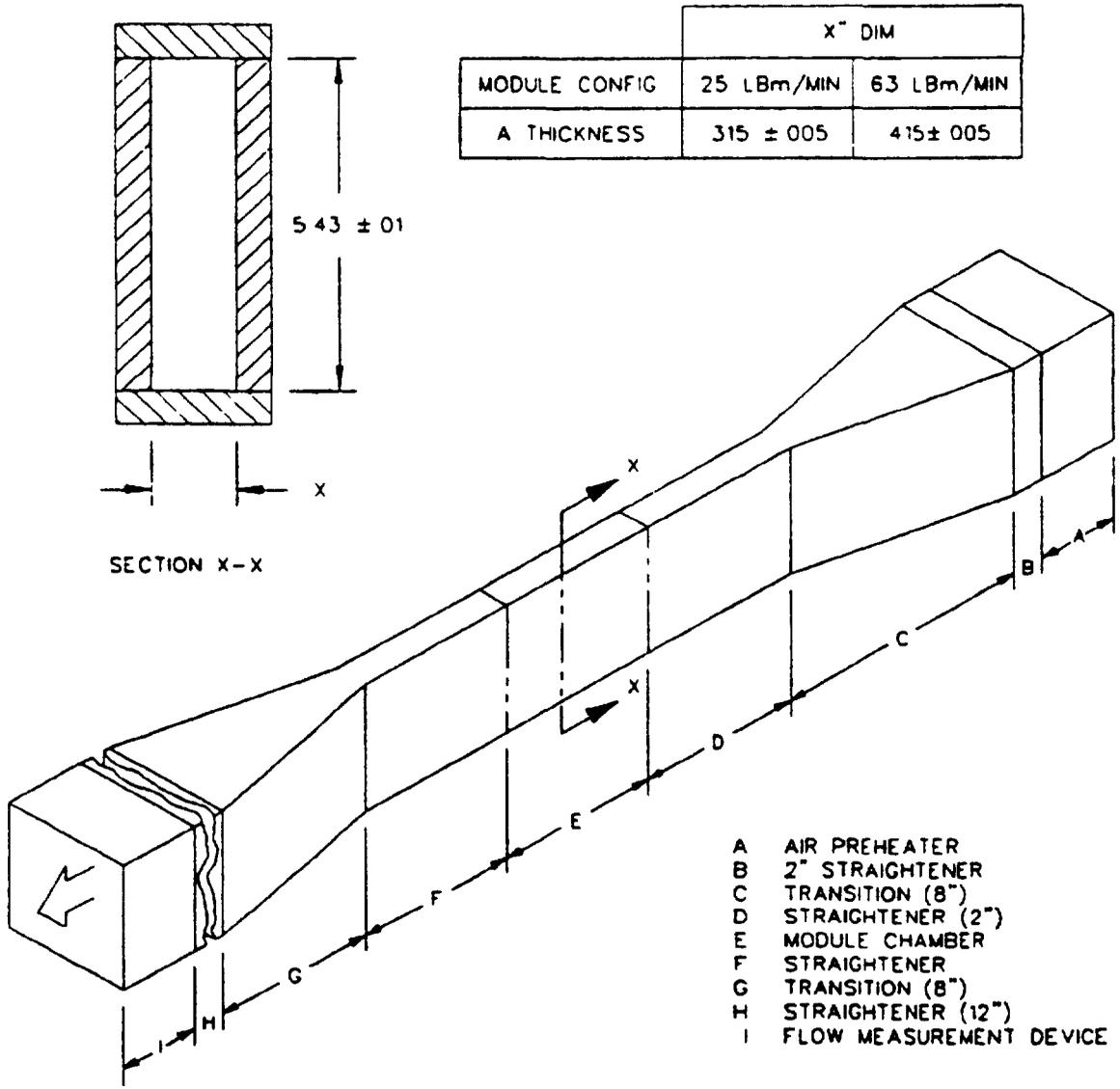


Notes:

- 1/ Contacts deleted for clarity.
- 2/ On 200 contact configurations, the contact stagger shown may be reversed with the shorter contacts being nearest the pin shields

FIGURE 32. Module configurations - side view.

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Inches	mm	Inches	mm	Inches	mm
0.005	0.127	0.415	10.541	5.43	137.922
0.25	6.35	0.63	16.002	8	203
0.315	8.001	2	51	12	305

FIGURE 33. Direct air impingement, format D.

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NOTES.

1. Dimensions are in inches.
2. Metric equivalents are given for information only.

FIGURE 33 Direct air impingement, format D - Continued.

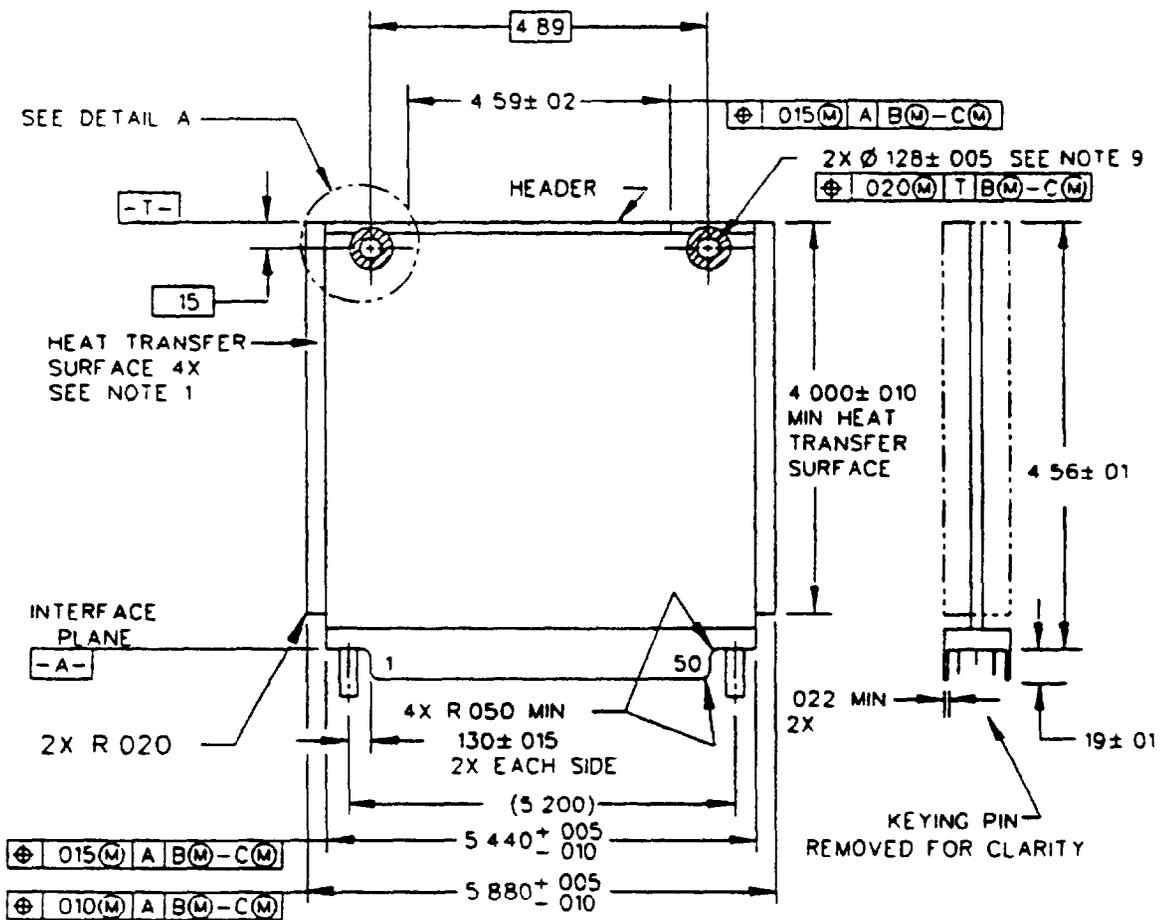


FIGURE 34. Module configurations

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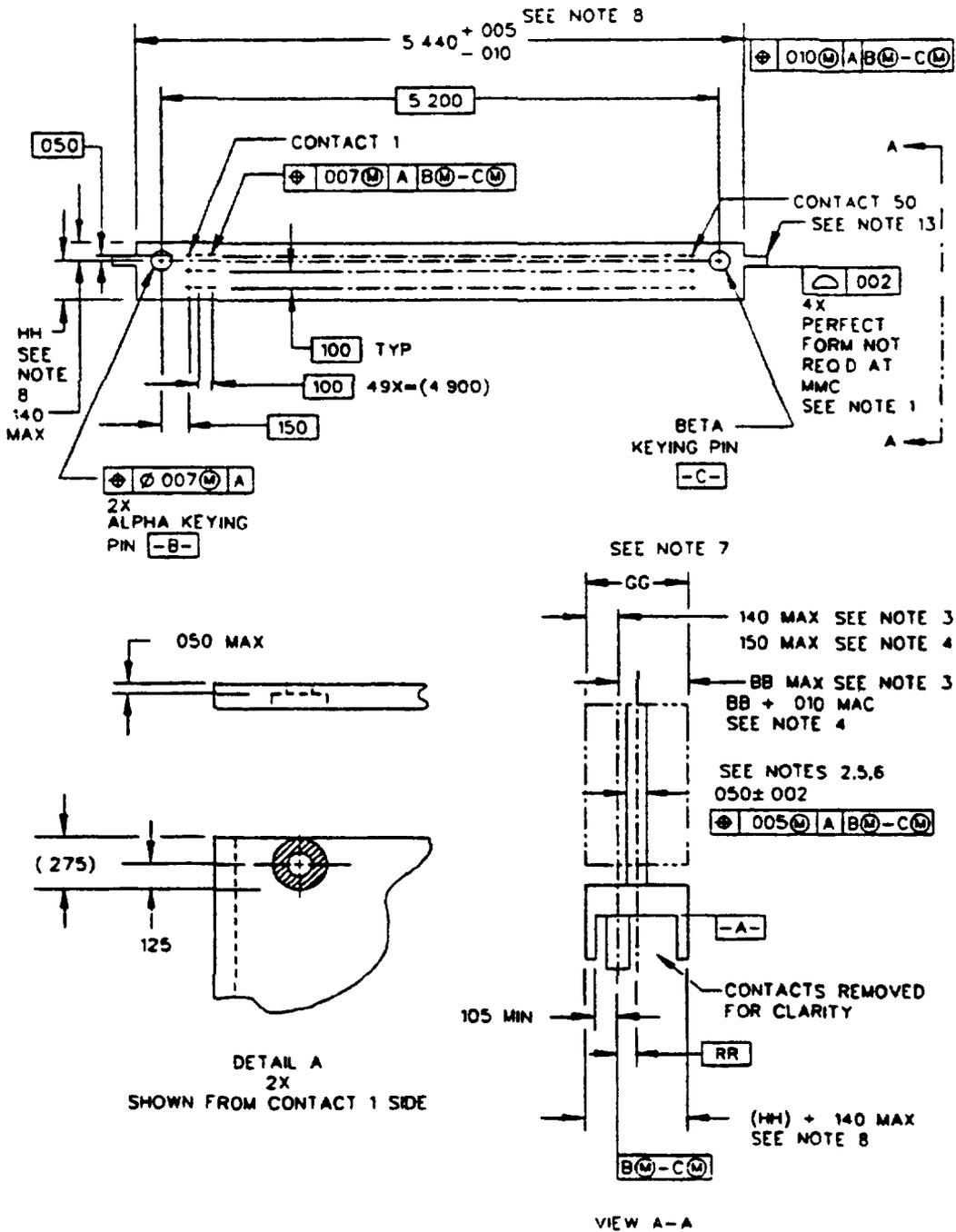


FIGURE 34. Module configurations - Continued

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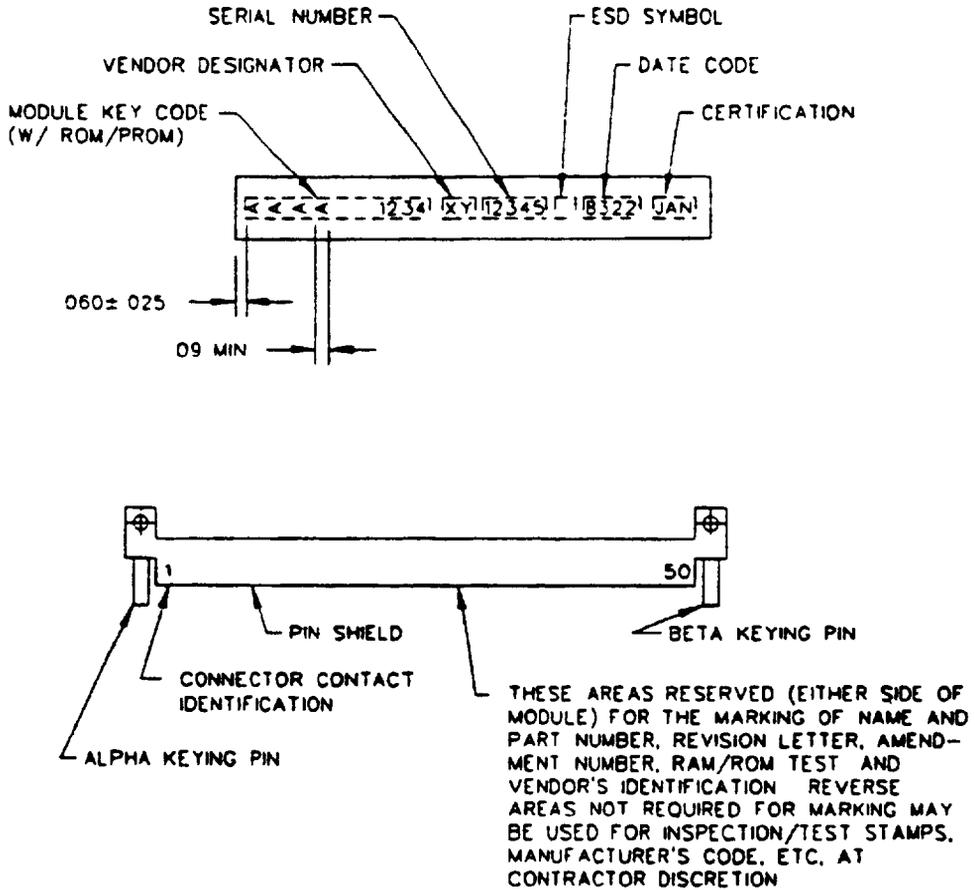
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.002	0.051	0.02	0.51	0.130	3.302	0.275	6.985	4.89	124.21
0.005	0.127	0.020	0.508	0.128	3.251	0.3	7.62	5.200	132.080
0.007	0.178	0.022	0.559	0.140	3.556	0.40	10.16	5.440	138.176
0.010	0.254	0.050	1.270	0.15	3.81	4.240	107.70	5.880	149.352
0.01	0.25	0.100	2.540	0.150	3.810	4.56	115.82		
0.015	0.381	0.125	3.175	0.19	4.83	4.59	116.59		

NOTES:

1. The heat transfer surface of the guide rib is defined by the 0.220 inch (5.59 mm) nominal by 4.000 inch nominal area of the frame on both ends. Both sides of each guide rib (4 surfaces total) shall have a surface finish of 25 microinch (0.00064 mm) or better, and coplanar surfaces have a profile of 0.002 inch. The end of each guide rib (0.050 inch by 4.000 inch) is not required to meet the surface finish requirements of the heat transfer surface.
2. The guide rib feature shall be contained within a 0.059 inch maximum (1.499 mm) zone.
3. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
4. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does have lateral translation (floating).
5. Modules employing the lateral displacement option (float) shall maintain the position of the guide ribs with respect to the connector datum (B-C) to the same tolerance as modules without the lateral displacement (nonfloat). The floating module will be allowed to be translated into position to meet this requirement. This requirement shall not alter the requirements of 30.1.1. The requirements of 30.1.1 shall be verified by a separate test.
6. These dimensions are applicable for locating the profile of the module guide rib with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
7. The GG maximum dimension applies to the module component profile.
8. See table X. These dimensions apply to the connector profile.
9. Crosshatched area to be free of obstruction for extraction purposes.
10. Dimensions are in inches.
11. Metric equivalents are given for general information only.
12. 150 contact connector shown as an example.
13. The 0.4 pitch guide rib does not center on keying pins. See table X.

FIGURE 34. Module configurations - Continued

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Inches	mm
0.025	0.635
0.060	1.524
0.09	2.29

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The 0.060 spacing between fin end and the key code shall be measured between the first letter of the key code and the fin part nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum.

FIGURE 35. Module marking areas.

APPENDIX E

DESIGN REQUIREMENTS FOR FORMAT E MODULES

10. SCOPE

10.1 Scope This appendix is a mandatory part of the standard for the design requirements for format E modules to be used in SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. GENERAL REQUIREMENTS

30.1 Mechanical configuration requirements. The basic mechanical configurations are specified on figures 36 and 37 with incremental growth in thickness specified in table XI. A typical 0.6 inch pitch module is shown on figure 38. Drawing practices shall be in accordance with DOD-STD-100.

30.1.1 Lateral displacement. The module may be designed to provide a lateral displacement between the module frame and connector of plus or minus 0.006 inch (0.152 mm) minimum from the center of the two guide rib profiles. The maximum force required to displace the module frame relative to the connector shall be 10 pounds (44.4 newtons). The force shall be applied equally at the points of attachment of the connector to the frame. If the lateral displacement option is exercised, the maximum location of any surface or feature of the connector when the connector is at its extreme displacement shall be in accordance with table XI. The use or nonuse of the lateral displacement option shall be stated in the detail specification.

30.2 Thermal requirements. The following thermal requirements shall apply.

30.2.1 Conduction cooling Modules shall be designed to be conduction cooled through the ribs and shall be capable of being cooled by the ribs with no other heat loss.

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TABLE XI. Module growth. 2/ 3/

Thickness	B	C	D
Module pitch <u>1/</u>	0.4 (10.2 mm)	0.5 (12.7 mm)	0.6 (15.2 mm)
Maximum module thickness, GG	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum connector profile, HH + 0.140 max	0.380 (9.652 mm)	0.480 (12.192 mm)	0.580 (14.732 mm)
Maximum number of contacts	150	200	250
Dimension RR (max) Keying pin to guide rib. (see figure 37)	0.050 (1.270 mm)	0.100 (2.540 mm)	0.150 (3.810 mm)
Dimension BB (max) (see figure 37)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.176 mm)
Dimension HH (max) (see figure 37)	0.240 (6.096 mm)	0.340 (8.636 mm)	0.440 (11.176 mm)
Guide rib thickness	0.050 (1.270 mm)	0.050 (1.270 mm)	0.125 (3.175 mm)

- 1/ Pitch refers to the distance between module centerlines for system packaging purposes.
2/ Dimensions are in inches.
3/ Metric equivalents are given for general information only.

30.2.2 Forced air across components cooling. Modules shall be designed for direct air impingement cooling over the components, and in addition, shall meet the rib cooling design requirements. The cooling design for direct air impingement shall be predicated upon a maximum airflow rate of 0.81 pound mass per minute (0.006 kilogram per second) at module interface temperature for the 0.4 inch (10.1 mm) pitch module when tested in a duct size of 6.75 inches (171.45 mm) high and 0.515 inch (13.081 mm) wide (see figure 39). Duct width shall be increased by 0.100 inch (25.400 mm) for each additional module thickness increment. For direct air impingement cooling, the maximum allowable static pressure loss shall be 0.30 inch (7.6 mm) of water when tested in the above configuration.

40. DETAILED REQUIREMENTS

40.1 Configuration. The basic module size has a span of 5.88 inches (149.35 mm) a thickness of 0.380 inches (9.652 mm) and is 6.68 inches (169.67 mm) high including keying pins. Modules may increase in thickness in accordance with table XI. Dimensions and tolerances shall be as specified on figure 37.

40.1.1 Circuitry. The module circuitry shall have a minimum clearance of 0.015 inch (0.381 mm) around all edges of the substrate or printed-board. The printed-board shall be further reduced to allow for insertion of the module extractor, to allow for any curvature of the frame from the rib edge to the flat surface, and to prevent component damage during module extraction.

40.1.2 Module header structure. The module header shall perform the following functions:

- (a) Module identification.
- (b) Module insertion and extraction.
- (c) Component protection.

40.1.2.1 Module identification. The module identification header shall have the configuration and marking as specified on figure 40.

40.1.2.2 Module insertion. The module header shall withstand 100 pounds (445 newtons) of insertion force.

40.1.2.3 Component protection. The header structure shall be designed to help prevent component damage during exposure to insertion and extraction.

40.1.3 Module frame. The module frame shall include module rib structures and extraction capability.

40.1.3.1 Module rib structure. The basic module configuration shall have two ribs; one located at the alpha end and one located at the beta end of the module (see figure 37).

40.1.3.2 Module rib function. The module ribs shall perform the following functions:

- (a) Alignment during insertion or extraction.
- (b) Cooling.

40.1.3.3 Module extractor interface. Modules shall have a set of two extractor holes located as shown on figure 37.

40.1.4 Module connector. The basic module connector shall have two rows of 50 metal blade contacts. Modules may increase contact quantity to three, four, and five rows of 50 contacts with all rows of 50 contacts to be complete as specified in table XI. All connectors shall be in accordance with MIL-C-28754 and conform to the requirements specified herein.

40.1.4.1 Connector location. The location of connectors shall be as shown on figure 37. Each connector shall have contacts identified by numbers indicating the first and last contact of the row closest to the pin shield as shown on figure 37.

40.1.4.1.1 Module contacts. The number of contacts on the module shall be as specified in the detail specification. The contact configuration is controlled only on that part of the contact protruding from the module connector surface (the interface plane).

40.1.4.2 Contact location. The location of contacts shall be as shown on figure 37.

40.1.4.3 Flexible circuits. A flexible circuit may be utilized as a means of terminating to the module circuitry. This flexible circuit shall meet the requirements of 5.2.2.3.

40.1.5 Module mechanical requirements. The following mechanical requirements apply.

40.1.5.1 Module integrity. Each module, with the connector and header structure assembled, shall withstand 10 cycles without damage or separation, a minimum axial force applied in 2 to 10 seconds normal to the interface plane equal to 100 pounds (445 newtons) on insertion and 4 ounces (1.1 newton) maximum per contact on extraction.

40.1.5.1.1 Module insertion. On insertion, a 100 plus 5, minus 0 pound (445 plus 22.3, minus 0 newton) force shall be uniformly applied on the top surface of the header.

40.1.5.1.2 Module extraction. On extraction, a 4.0 plus 0, minus 0.1 ounce (1.1 plus 0, minus 0.03 newton) force per contact shall be applied at the two extractor holes.

40.1.5.1.3 Module header integrity. The header structure shall provide the strength required to install the module and meet the requirements of 40.1.5.1.1.

40.1.5.2 Module torque requirements. The module shall withstand the following torque requirements.

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40.1.5.2.1 Module header torque. The module header shall withstand a 10 inch-pound (1.14 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.2.2 Module torque. The module shall withstand a 25 inch-pound (2.83 newton-meter) torque applied in 2 to 10 seconds and maintained for 10 to 15 seconds in both directions along the header.

40.1.5.3 Module cantilever load. The module shall withstand a force of 5 pounds (22 newtons). The force shall be applied in two directions and shall be applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.5.4 Durability. The module shall withstand 500 cycles of mating and unmating with no degradation of module performance. The module shall also withstand 500 cycles of testing to simulate the use of thermal clamping devices.

40.1.5.4.1 Clamping durability (floating modules). Modules which exercise the lateral displacement option shall withstand durability clamping by being displaced 0.006 inch (0.152 mm) from both sides of the centerline of the guide rib profiles.

40.1.5.4.2 Clamping durability (nonfloating modules). Modules that do not exercise the lateral displacement option shall withstand durability clamping by being displaced up to 0.0030 plus 0.0005, minus 0.0000 inch (0.0762 plus 0.0127, minus 0.0000 mm) from either side of the center line of the guide rib profiles by uniformly applying a constant maximum force of 75 pounds (334 newtons) to each guide rib.

40.1.5.5 Keying pin pushout. Each keying pin shall withstand a pushout force of 40 pounds (178 newtons) minimum applied in 2 to 10 seconds and maintained for 10 to 15 seconds.

40.1.6 Finishes and protective treatments. The following finishes and protective treatment requirements apply. Acceptance or approval of a finish or protective treatment shall not be construed as an assurance of

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the acceptance of the finished product. MIL-STD-889 shall be used in the selection of finishes and protective treatments to assure galvanic corrosion protection.

40.1.6.1 Module surface finish. The surface finish of the module shall be free of any imperfections that have a detrimental effect upon the performance of the module. The heat transfer surface finish of the ribs (as shown in figure 37) shall be 25 microinch (0.00064 mm) or better.

40.1.6.2 Copper and copper composite frame plating. Copper and copper composite frames shall be electroless nickel plated in accordance with MIL-C-26074, class 1, grade A.

40.1.6.3 Aluminum frame plating. Aluminum frames shall receive an anodic treatment in accordance with MIL-A-8625, type III, class 2, black.

40.1.6.4 Connector body plating. Any aluminum parts utilized on the connector shall receive an anodic treatment in accordance with MIL-A-8625, type III, class 2, black.

40.1.7 Test points. The module design may provide for test points.

40.1.7.1 Acceptance testing. Final electrical acceptance testing shall be performed through the input/output connector contacts on the module.

40.1.7.2 Fault isolation testing. For the purpose of component fault isolation testing, test points may be used in addition to the input/output connector contacts on the module. The following design and usage rules shall apply:

- (a) Any output may be accessed.
- (b) Only those inputs which will not effect timing requirements of module operation shall be accessed.
- (c) Physical breaking of module signal paths through test points shall not be allowed.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that CCTs are not exceeded when modules are operated at typical power dissipation at the maximum thermal interface temperature for the appropriate class.

40.2.2 Typical power dissipation. Typical power dissipation means the maximum recommended power dissipation under nominal module operating conditions. Typical power values for semiconductor devices are derived from contractor developed characterization data (if available) or secondly, from vendor data sheets. When the typical power dissipation for a component cannot be determined, the maximum power dissipation for worse case module operating conditions shall be used.

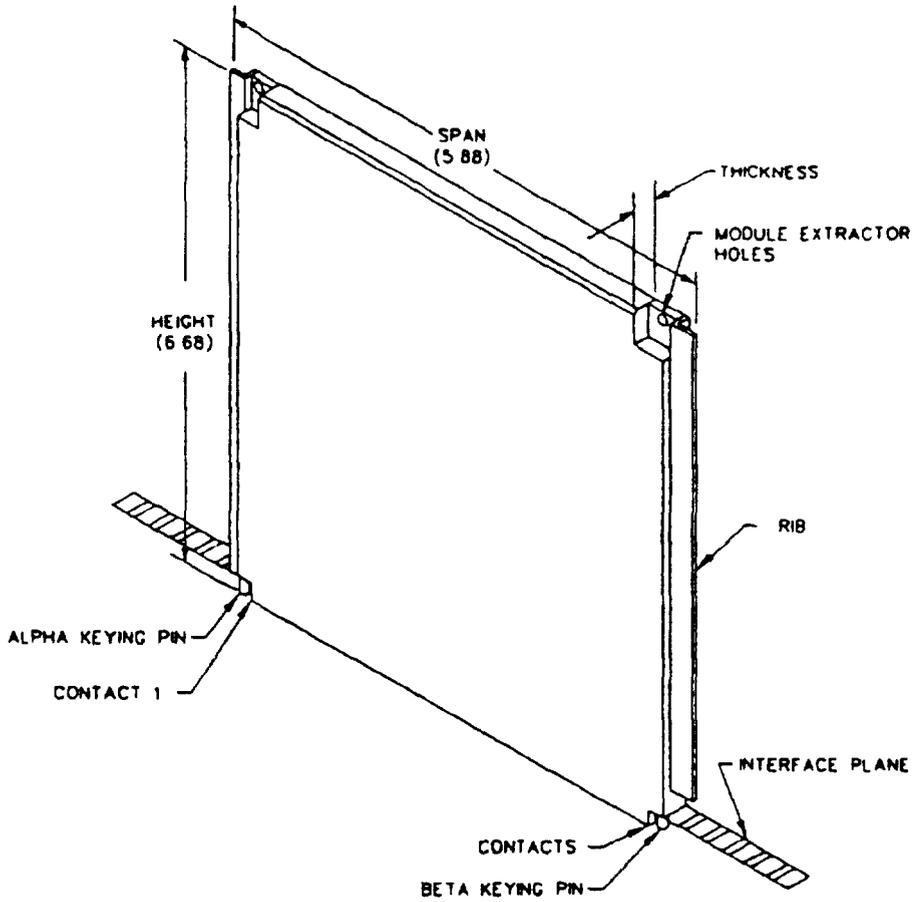
40.2.2.1 Recommended module power dissipation. The maximum recommended module power dissipation is 35 watts under typical operating conditions. Detail module specifications covering any module design dissipating greater than the above recommended value shall have the method of cooling specified for future application guidance on the use of the module.

40.2.3 Component temperatures The following requirements for CCT and TCCT apply.

40.2.3.1 CCT. The CCT for semiconductor devices dissipating 2.5 watts or less typical power shall be 85°C junction for classes I and III and 110°C junction for classes II and IV. For semiconductors dissipating more than 2.5 watts typical power, the CCT may increase 15°C per watt. In no instance may any individual junction CCT exceed 100°C for classes I and III or 125°C for classes II and IV regardless of the typical power dissipation of the device. In no case shall a component have its maximum rated junction temperature exceeded. For nonsemiconductor components, the CCT shall be equal to the individual component's maximum specified operating temperature minus 30°C and shall be specified on the component's hottest external area.

40.2.3.2 TCCT. The TCCT for all devices shall be the appropriate CCT plus 20°C.

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Inches	mm
5.88	149.35
6.68	169.67

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 36 Module outline.

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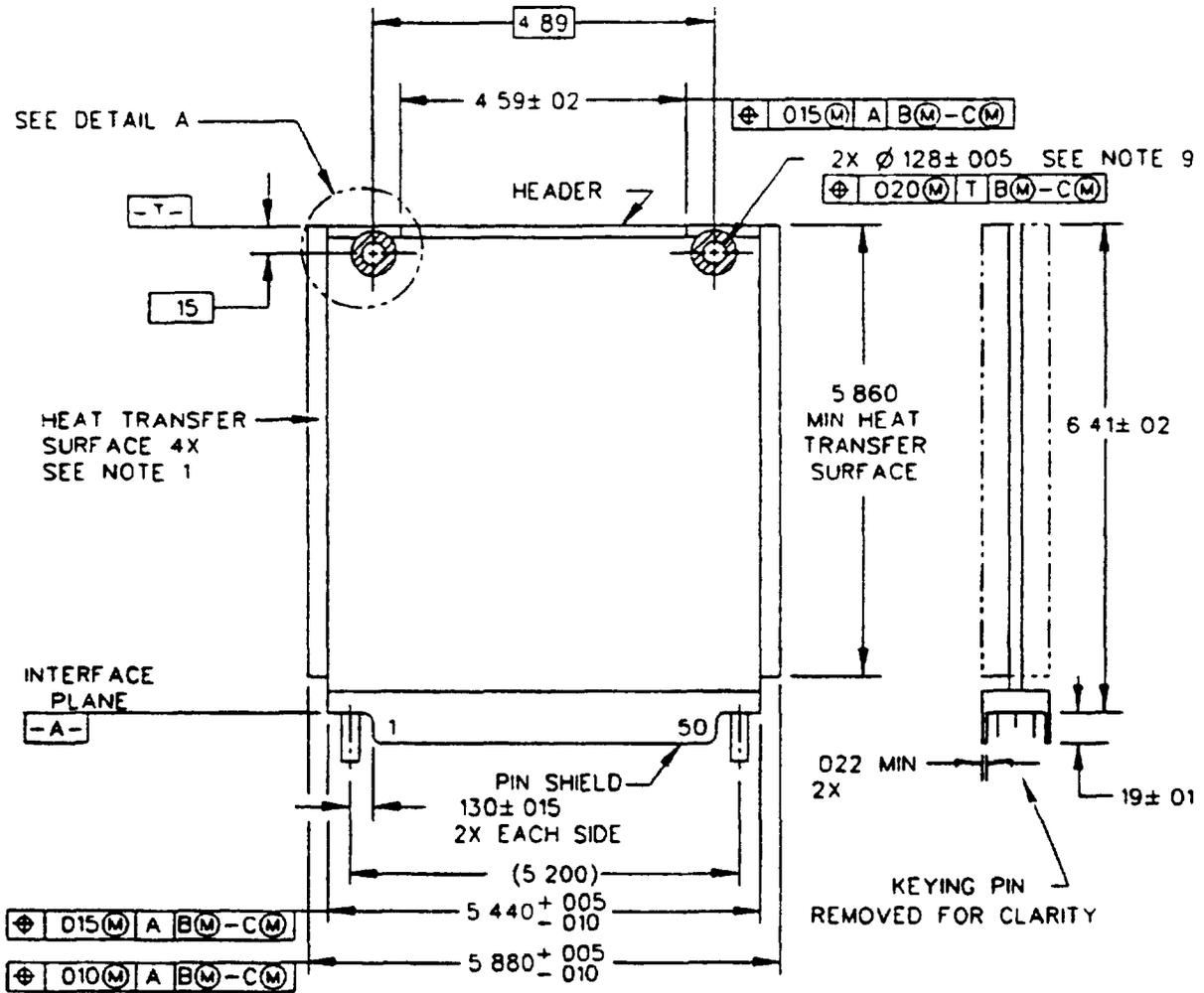


FIGURE 37. Module configurations

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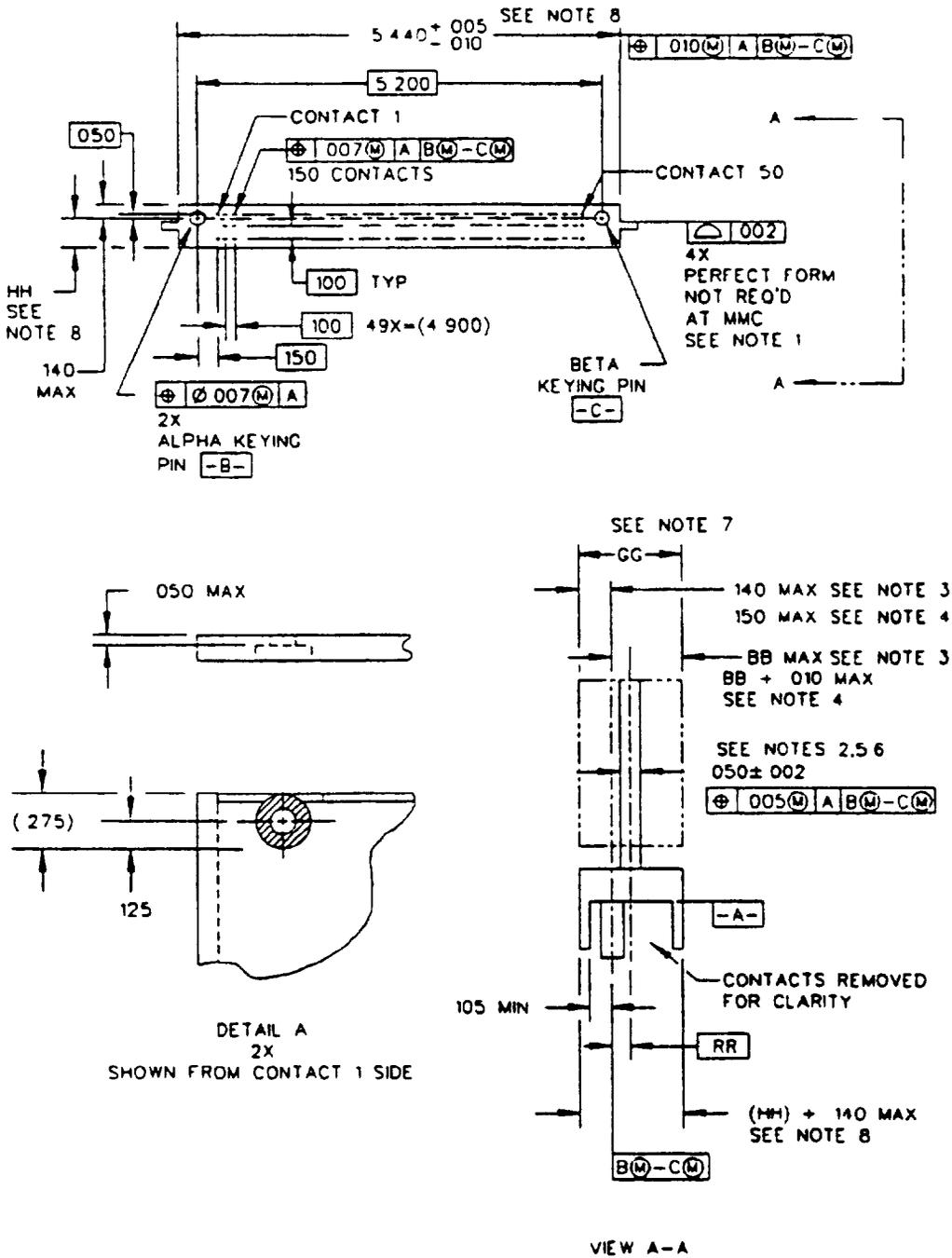


FIGURE 37. Module configurations - Continued.

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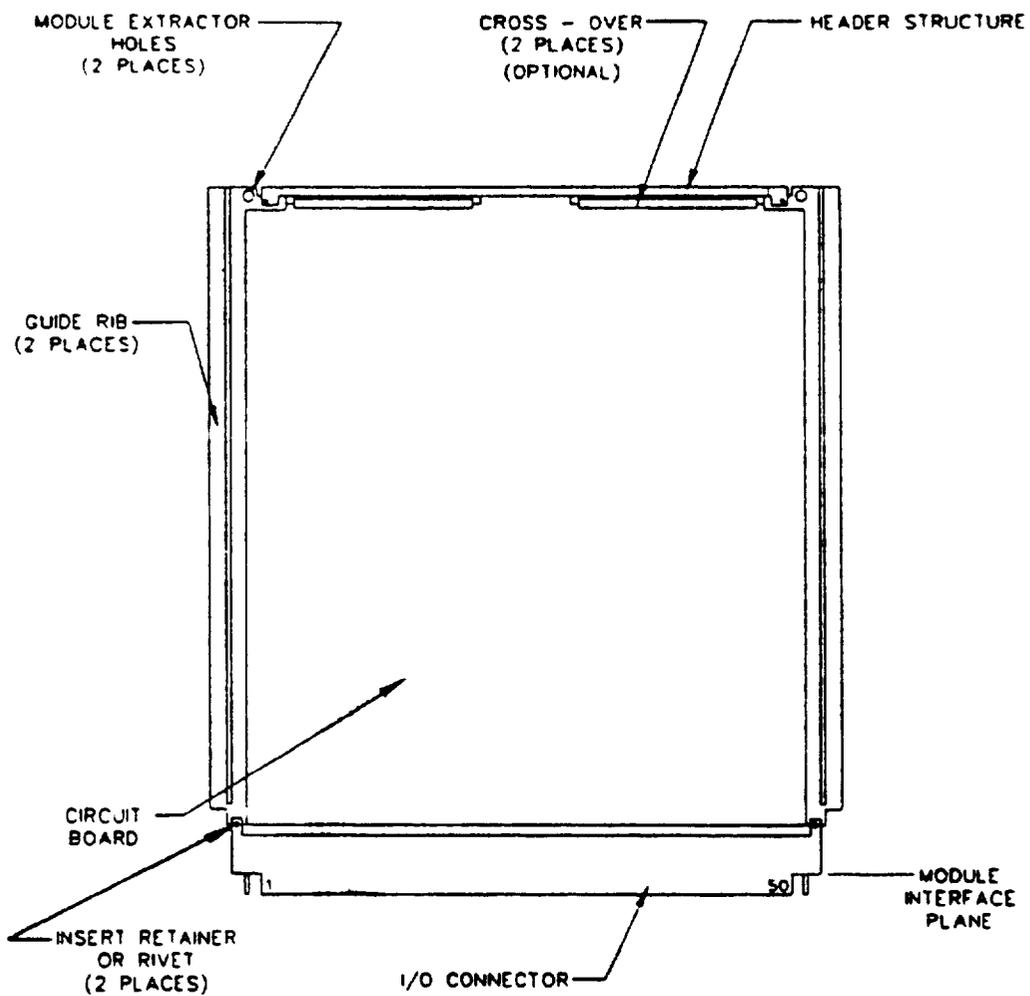
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
0.002	0.051	0.02	0.51	0.125	3.175	0.19	4.83	5.440	138.178
0.005	0.127	0.020	0.508	0.128	3.251	0.275	6.985	5.860	148.844
0.007	0.178	0.022	0.559	0.130	3.302	0.40	10.16	5.880	149.352
0.01	0.25	0.050	1.270	0.140	3.556	4.59	116.59	6.41	162.81
0.010	0.254	0.100	2.540	0.15	3.81	4.89	124.21		
0.015	0.381	0.105	2.667	0.150	3.810	5.200	132.080		

NOTES:

1. The heat transfer surface of the guide rib is defined by the 0.220 inch (5.588 mm) nominal by 5.860 inch nominal area of the frame on both ends. Both sides of each guide rib (4 surfaces total) shall have a surface finish of 25 microinch (0.00064 mm) or better, and coplanar surfaces shall have a profile of 0.002 inch. The end of each guide rib (0.125 inch by 5.860 inch) is not required to meet the surface finish requirements of the heat transfer surface.
2. The guide rib feature shall be contained within a 0.059 inch (1.499 mm) max zone for 0.4 and 0.5 pitch. The feature shall be contained within a 0.129 inch (3.28 mm) max zone for 0.6 pitch modules (rib thickness 0.125 plus or minus 0.002).
3. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
4. These dimensions are applicable for locating the module body (components) with respect to the connector datum B-C for a module that does have lateral translation (floating).
5. Modules employing the lateral displacement option (float) shall maintain the position of the guide ribs with respect to the connector datum (B-C) to the same tolerance as modules without the lateral displacement (nonfloat). The floating module will be allowed to be translated into position to meet this requirement. This requirement shall not alter the requirements of 30.1.1. The requirements of 30.1.1 shall be verified by a separate test.
6. These dimensions are applicable for locating the profile of the module guide rib with respect to the connector datum B-C for a module that does not have lateral translation (nonfloating).
7. The GG maximum dimension applies to the module component profile.
8. See table XI. These dimensions apply to the connector profile.
9. Crosshatched area to be free of obstruction for extraction purposes.
10. Dimensions are in inches.
11. Metric equivalents are given for general information only.
12. 150 contact connector is shown as an example.

FIGURE 37. Module configurations - Continued.

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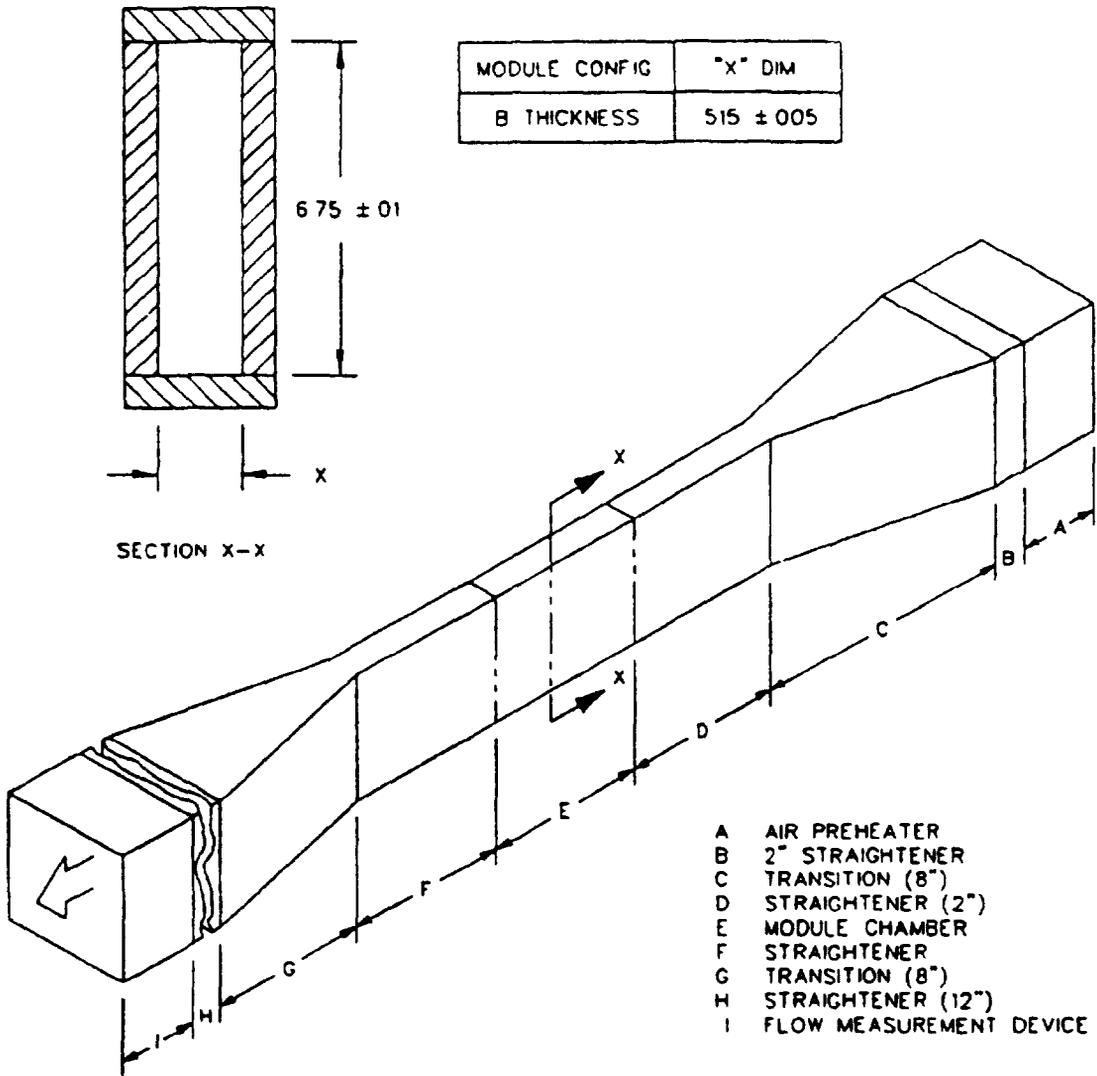


NOTE:

1. Leads were omitted for clarity.

FIGURE 38. Typical 0.6 inch pitch module.

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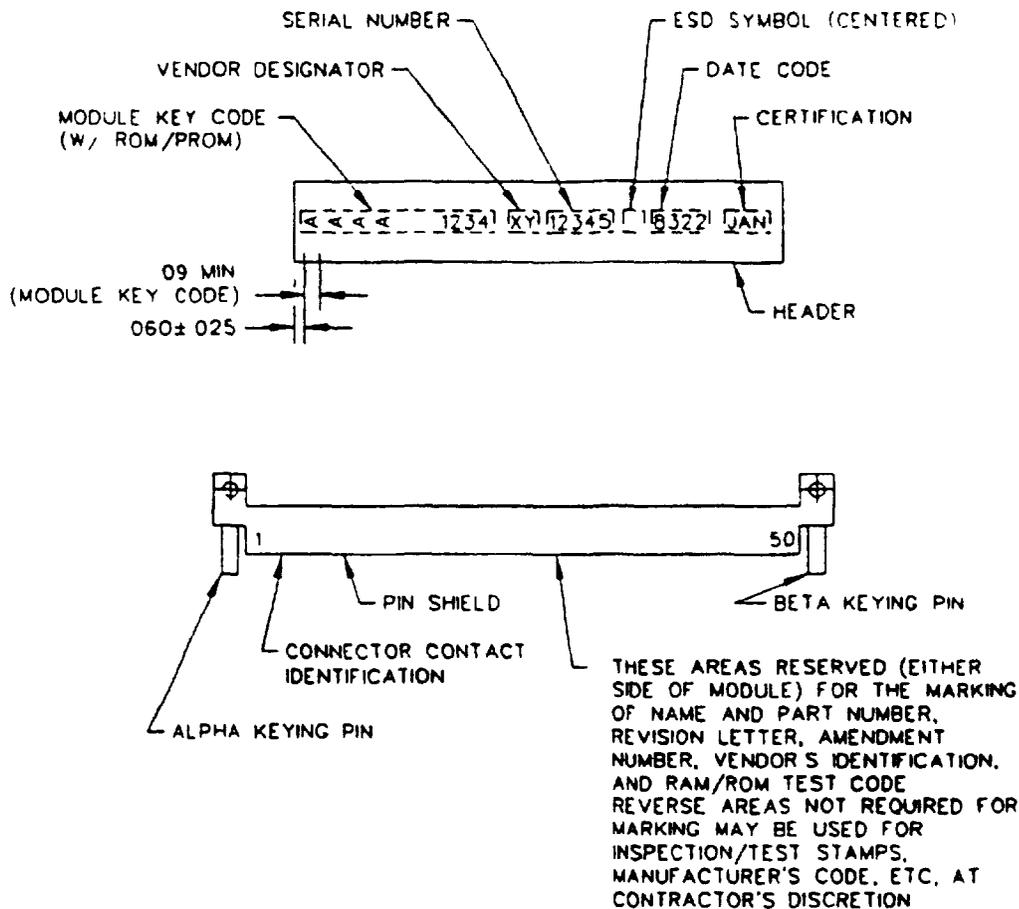
Inches	mm	Inches	mm	Inches	mm
0.005	0.127	2	50	12	305
0.01	0.25	6.75	171.45		
0.515	13.081	8	203		

NOTE:

1. Dimensions are in inches.
2. Metric equivalents are given for information only.

FIGURE 39. Direct air impingement, format E.

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Inches	mm
0.025	0.635
0.060	1.524
0.09	2.29

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The 0.060 spacing between the fin end and the key code shall be measured between the first letter of the key code and the part of the fin nearest the alpha end of the module having a width of 0.150 inch (3.810 mm) minimum

FIGURE 40. Module marking areas.

APPENDIX F

THICK FILM MULTILAYER INTERCONNECT BOARD DESIGN REQUIREMENTS

10 SCOPE

10.1 Scope. This appendix is a mandatory part of the standard and establishes design requirements for a thick film ceramic circuit board containing two or more layers of interconnection separated by dielectric, which is intended for surface mounted components. The information contained herein is intended for compliance.

10.2 Classification. Thick film multilayer interconnect boards shall be of the types shown, as specified.

Type 1 - Inert fired systems

Type 2 - Air fired systems

20. APPLICABLE DOCUMENTS

20.1 Non-Government publications. The following documents form a part of this appendix 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 NATIONAL STANDARDS INSTITUTE (ANSI)

Y14.1 Drawing Sheet Size and Format

Y14.5 Dimensioning and Tolerancing

(Applications for copies should be addressed to the American National Standards Institute Inc, 1430 Broadway, New York, NY 10018.)

INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

1402 Hybrid Circuit Design Guide

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(Applications for copies should be addressed to the International Society for Hybrid Microelectronics, PO Box 2698, Reston, VA 22090-2698.)

INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS

D-350

End Product Description in Numeric Form

(Applications for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Avenue, Lincolnwood, IL 60646).

(Non-Government publications are normally available from the organization that prepares or distributes the documents. These documents also may be available in or through libraries or other informational services)

30. DEFINITIONS

30.1 Terms and definitions. The terms and definitions used herein shall be in accordance with this appendix, ISHM-STD-1402, MIL-M-38510, and MIL-M-28787D, appendix B.

30.1.1 Ceramic blank. Ceramic blank is the supporting material upon which the elements of a ceramic multilayer interconnect board are deposited.

30.1.2 Circuit definition. Circuit definition is the fidelity of reproduction of the pattern screened and fired onto the ceramic blank relative to the original master pattern.

30.1.3 Conductor. Conductor refers to all metal used for electrical interconnection.

30.1.4 Datum. Datum is an exact point, axis, or plane derived from the true geometry counterpart of a specified feature. The origin from which the location or geometric characteristics of features of a part are established.

30.1.5 Dielectric. The term dielectric refers to an insulating material used to electrically isolate conductors.

30.1.6 Hole. A hole is a designed opening in the ceramic blank.

30.1.7 Layer. A layer is an individual deposition of conductive material comprised of conductors and terminations.

30.1.8 Make-up interconnect layer. A make-up interconnect layer is a layer that serves to prevent excessive via length and accommodates additional conductor lines.

30.1.9 Master drawing. Master drawing is a documentation set which contains all information required to describe a multilayer interconnect board (MIB), including the master pattern.

30.1.10 Master pattern. Master pattern is the artwork used to describe a multilayer interconnect board. This includes power and ground planes, interconnect, via fill, dielectric, top metallization pattern, and overglaze (if applicable).

30.1.11 Multilayer interconnect board. Multilayer interconnect board is a ceramic circuit board containing two or more layers of interconnection separated by dielectric.

30.1.12 Overglaze. Overglaze is an insulating material applied in order to mechanically and environmentally protect the underlying dielectric and interconnect pattern.

30.1.13 Probe points. Probe points are predetermined locations on the MIB where electrical contact may be made to exposed areas of the circuitry for electrical measuring purposes. Component mounting lands are considered probe points.

30.1.14 Via. Via refers to a designed opening in the dielectric.

30.1.15 Via fill. Via fill is conductive material within the dielectric vias which form the interconnect between metal layers.

40. GENERAL REQUIREMENTS

40.1 Design features The design features of the MIBs shall be in accordance with this appendix and the master drawing.

40.2 Master drawing. The master drawing shall be prepared in accordance with DOD-STD-100. It shall include all appropriate detail MIB requirements and the following:

- (a) The type, size, and shape of the MIB.
- (b) The size, location, and tolerance of all holes therein.
- (c) Location of traceability marking; identification marking; size, shape, and location of reference designation and legend markings, if required.
- (d) Shape and arrangement of individual conductors, dielectric, overglaze (if applicable), and via fill patterns. Copies of the master pattern or copies of the artwork may be used to define these patterns.
- (e) Dimensions for critical pattern features which may affect circuit performance.
- (f) Deviations to this appendix.
- (g) Minimum line width, spacing, via size, land size, dielectric thickness between layers, and conductor thickness of the finished MIB.
- (h) Material requirements.
- (i) Identification of probe points required for electrical testing of the finished MIB.
- (j) Applicable fabrication specification.

(k) Registration of artwork to the ceramic blank

40.2.1 Single-sheet master drawing Wherever practicable, all information shall be placed on one sheet; however, if the complexity of the pattern would cause a drawing to become complicated or difficult to interpret, a multisheet master drawing shall be prepared.

40.2.2 Multisheet master drawing. The first sheet of the multisheet master drawing set shall establish the size and shape of the MIB and location of the final land layer to the ceramic blank, and shall contain all notes. Any and all pattern features not defined by the master pattern shall be dimensioned, either specifically or by notes. Subsequent sheets shall establish the shape and arrangement of the conductor and dielectric patterns of the MIB. Conductor layers shall be numbered consecutively starting with the conductive layer nearest the ceramic blank as layer 1. When continuation sheets of a drawing are used for conductor pattern definition, they need not be prepared on standard drawing forms provided standard sheet sizes are used with standard continuation sheet title blocks located in the lower right corner of each sheet in accordance with ANSI-Y14.1.

40.2.3 Master patterns by automated techniques. When automated techniques are used or specified in the contract or order, a magnetic tape or card deck shall be generated containing all the instructions necessary for making each master pattern and shall meet the requirements of IPC-D-350.

40.2.4 Location dimensioning. All features shall be located by use of a grid system, except where necessary to mate parts not on grid. Any features not on grid shall be individually located. The basic modular units of length shall be multiples of 0.005 inch (0.127 mm) and shall be applied in the X and Y axes. Dimensioning and tolerancing practices used in master drawings shall be in accordance with ANSI-Y14.5.

40.2.5 Registration datums. There shall be at least two datums located as far apart as practical within the outline of the MIB for registration alignment.

40 2 6 Government furnished master drawings and master patterns When master drawings and master patterns are furnished to the contractor by the Government, the design features of this specification shall apply.

40 3 Master pattern. The accuracy of the master pattern shall be such that each master pattern shall have all centers of terminal areas, conductors, and other features located within 0.0005 inch (0.0127 mm) radius of the true grid position established for the layer, and shall be such that for the composite master pattern, the features of all layers shall coincide within 0.001 inch (0.025 mm) radius of the true grid position, when measured at 20 plus or minus 1°C, and 50 plus or minus 5 percent relative humidity after the material has stabilized.

50. DETAILED REQUIREMENTS

50.1 Conductors.

50.1.1 Conductor width and thickness. The design width and thickness of conductors on the finished MIB shall be determined on the basis of the current carrying capacity required. Conductor lines shall be a minimum of 0.006 inch (0.152 mm) in width. Solderable conductive pattern shall be a minimum thickness of 0.0007 inch (0.0178 mm) for Type 2 and 0.0005 inch (0.0127 mm) for Type 1. Inner layer conductor thickness shall be a minimum of 0.0004 inch (0.0101 mm).

50 1.1.1 Conductor line routing. Conductor lines shall be generally routed 90 degrees to the previous layer. This applies to all interconnect layers except for the make-up interconnect layer.

50.1.2 Conductor spacing. The minimum spacing between vias shall be 0.008 inch (0.203 mm). The minimum spacing between all other conductive elements on an individual conductor layer shall be 0.005 inch (0.127 mm) (see figure 41).

50.1.3 Spacing conductor to dielectric edge, to substrate edge.

50.1.3.1 Conductive layer to the edge of the dielectric. For all internal layers, the overlying dielectric shall extend beyond the edge of the conductive layer by a minimum of 0.010 inch (0.254 mm).

50.1.3.2 Connector lands to the edge of the ceramic and dielectric Connector lands located on the ceramic base shall be spaced a minimum of 0.010 inch (0.254 mm) from the edge of the ceramic. Connector lands located on dielectric shall be spaced a minimum of 0.005 inch (0.127 mm) from the edge of the dielectric.

50.1.3.3 Component mounting lands to edge of top dielectric. Spacing from the component mounting lands to edge of top dielectric shall be a minimum of 0.010 inch (0.254 mm).

50.2 Vias.

50.2.1 Via size. Vias shall be a minimum of 0.008 inch (0.203 mm) squared, or equivalent cross sectional area. If non-square vias are used, the minimum linear dimension shall be 0.008 inch. Maximum depth of any stacked via fills shall not exceed 0.008 inch.

50.2.2 Vias to edge of dielectric. Edge of vias to edge of dielectric shall be a minimum of 0.010 inch (0.254 mm).

50.2.3 Via alignment. Via fills to probe points shall fall entirely within the confines of the probe point periphery. Conductors intersecting with via fills shall have an overlap at least equal to the designed conductor width. The via fill need not be centered on the conductor (see figure 42).

50.3 Dielectric.

50.3.1 Dielectric thickness. The fired dielectric thickness between conductive layers shall be 0.0025 inch (0.0635 mm) minimum for type 1 and 0.0015 inch (0.0581 mm) minimum for type 2, with a minimum of two depositions required.

50.3.2 Dielectric to edge of ceramic. The spacing between dielectric and edge of substrate shall be 0.010 inch (0.254 mm) minimum except in the connector land area where the minimum spacing shall be 0.005 inch (0.127 mm).

50.4 Overglaze

50.4.1 Overglaze thickness. The minimum total thickness of the overglaze shall be 0.0005 inch (0.0127 mm), with a minimum one or more depositions. The overglaze coating shall completely cover the circuitry including the edges of the dielectric, except for the probe points. Overglaze is mandatory on MIBs utilizing a copper thick film system whose dielectric does not meet the overglaze hermeticity current leakage requirements of MIL-M-28787, appendix B.

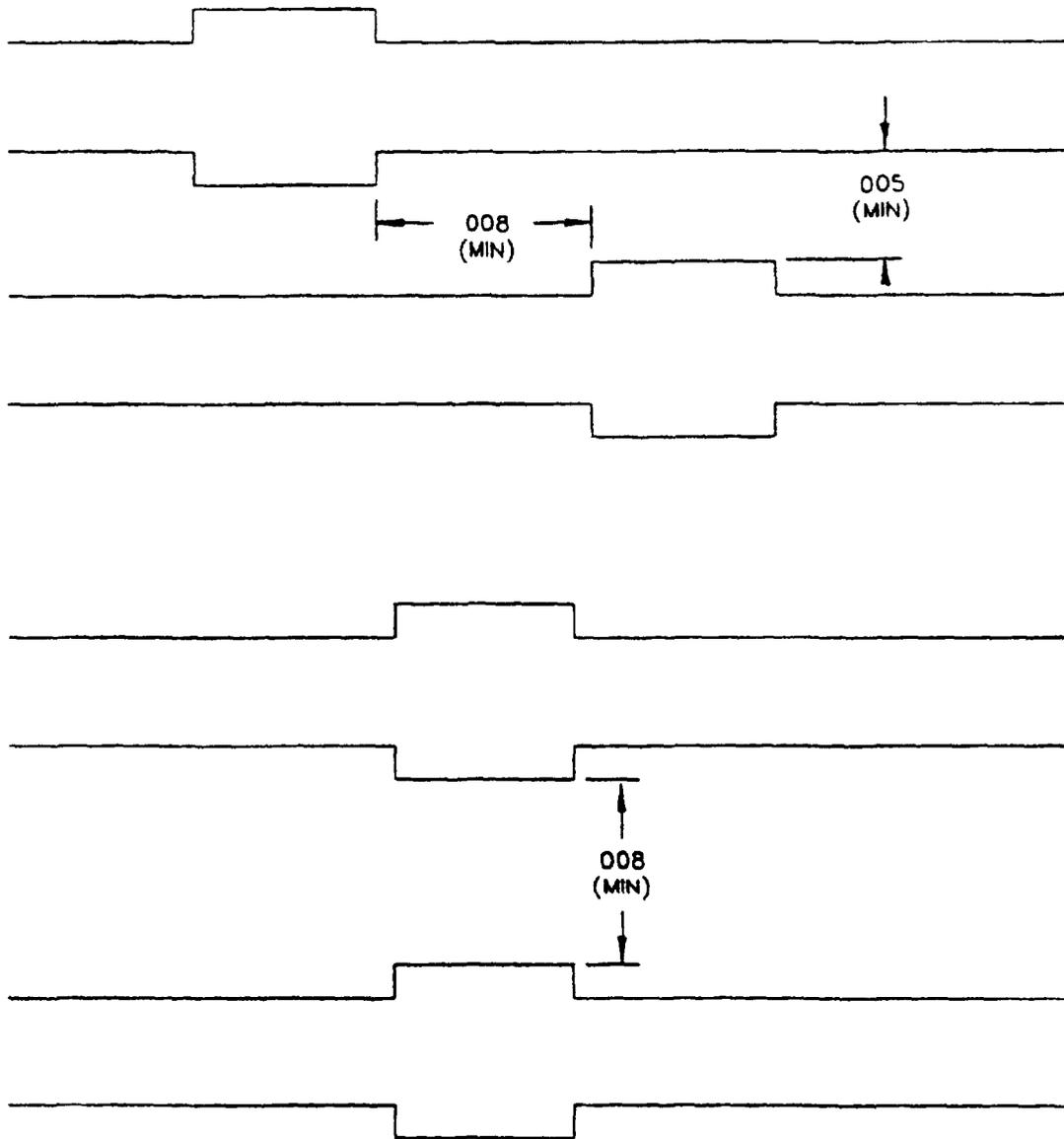
50.5 Soldering terminations.

50.5.1 Leaded component lands. MIB lands shall have a minimum width equal to the component lead width and minimum length equal to twice the component lead width or 0.030 inch (0.762 mm), whichever is greater (see figure 43).

50.5.2 Leadless chip carriers (LCC) lands. The MIB land shall, as a minimum, have the same dimensions as the individual terminals on the underside of the LCC to be used plus an additional 0.015 inch (0.381 mm) added to the length. The MIB land is required to extend 0.015 inch minimum beyond the edge of the LCC (not including the added distance due to the castellations) (see figure 44). The spacing between LCC's shall be a minimum of 0.050 inch (1.25 mm).

50.5.3 Chip capacitor and chip resistor design requirements. The MIB land shall extend under the chip at least the same distance as the metallization on the underside of the chip. Spacing between chips shall be a minimum of 0.050 inch (1.270 mm). The MIB land shall extend the same distance beyond the end of the chip as the metallization on the underside of the chip, or 0.015 inch (0.381 mm) whichever is smaller. The printed-board solder land shall have enough width beyond the nominal width of the chip to allow for proper solder wetting on the sides of the chip metallized terminations (see figure 45). Designs which utilize parts which do not have metallization on the sides are not required to have MIB land extension on the side.

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NOTES:

1. Dimensions are in inches.

FIGURE 41. Conductor spacing.

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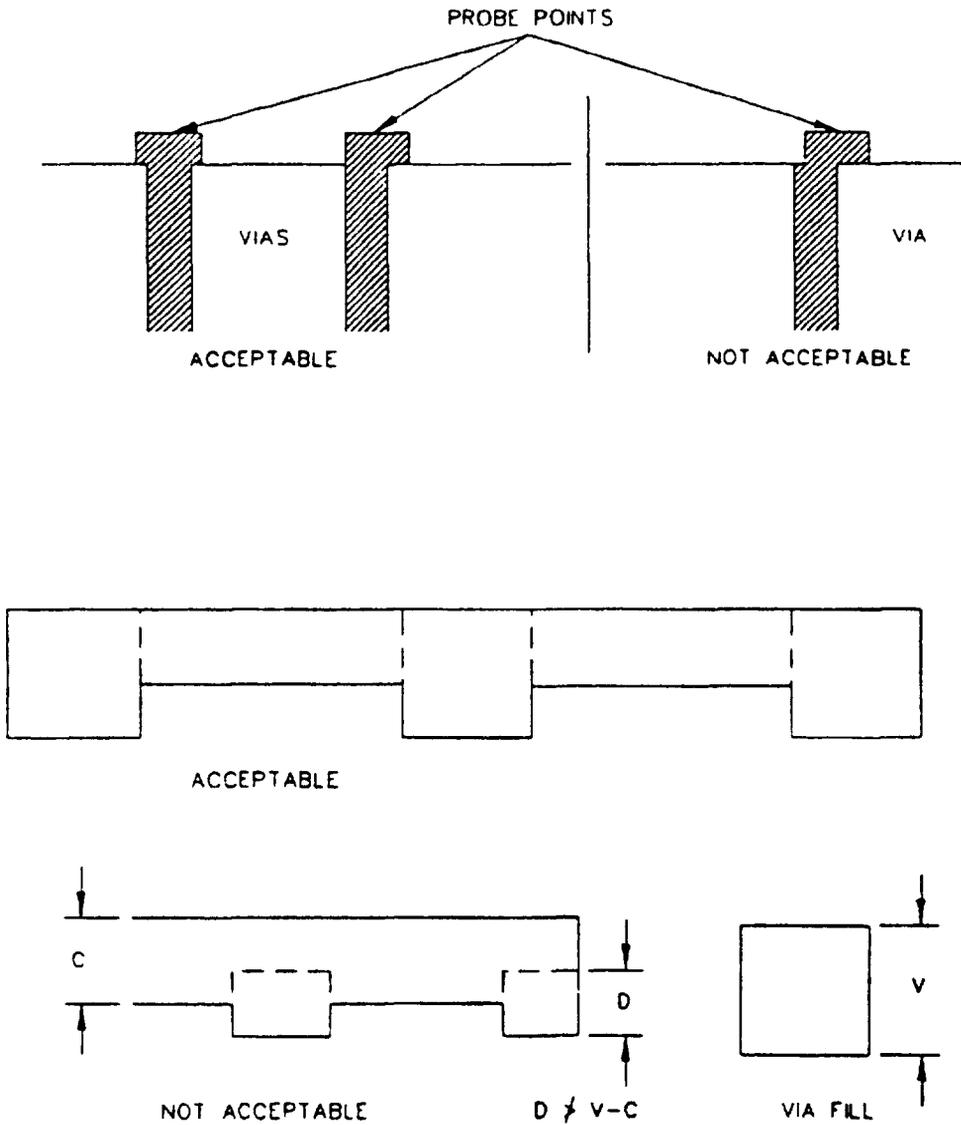
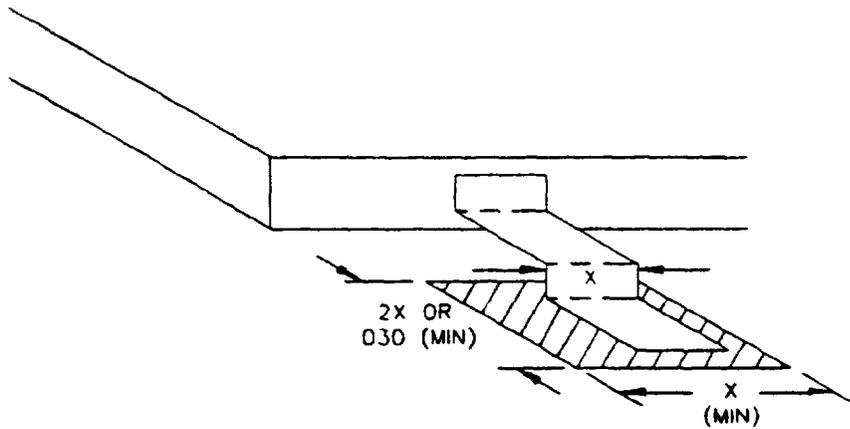


FIGURE 42. Via alignment.

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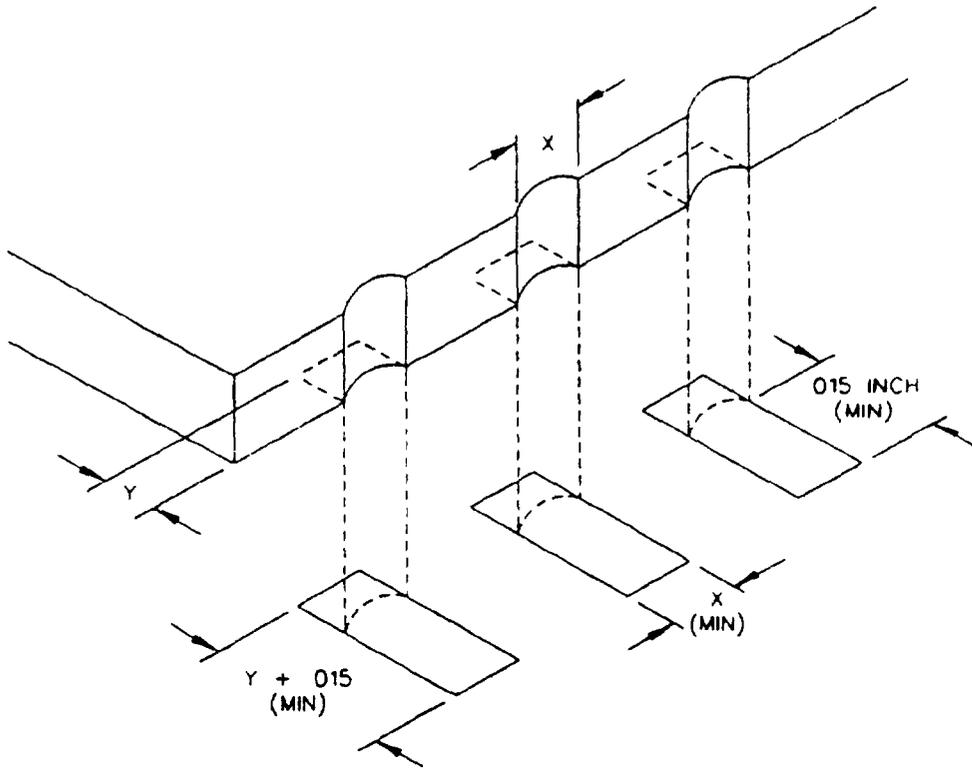
Inches	mm
0.030	0.762

NOTES:

1. Dimensions are in inches.
2. Metric equivalent is for general information only.

FIGURE 43. Leaded component lands.

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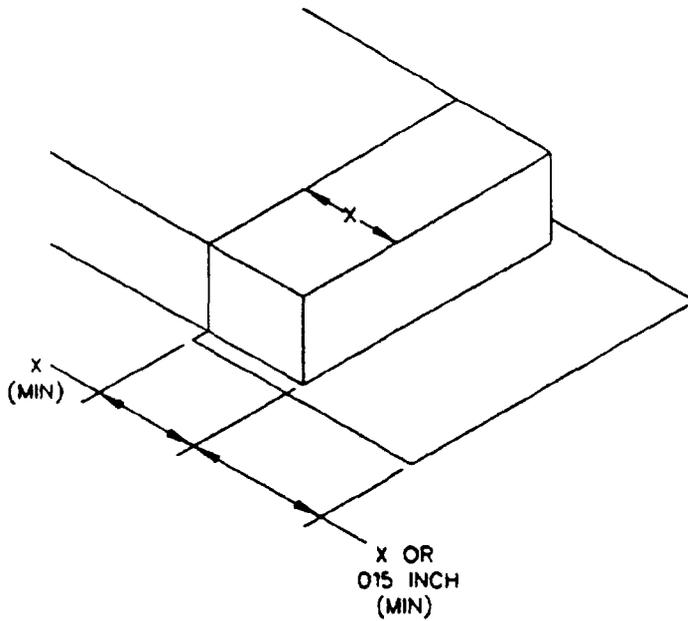
Inches	mm
0.015	0.381

NOTES:

1. Dimensions are in inches.
2. Metric equivalent is for general information only.

FIGURE 44. Leadless chip carrier lands.

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Inches	mm
0.015	0.381

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are for general information only.

FIGURE 45. Chip component lands.

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PARTS DERATING, THERMAL PERFORMANCE, AND FAILURE RATE PREDICTION
FOR STANDARD ELECTRONIC MODULES

10 SCOPE

10.1 Scope This appendix is a mandatory part of the standard for the requirements and procedures for parts derating, thermal performance evaluation, and failure rate prediction of the SEM. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specification and handbooks. The following specification 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.

SPECIFICATIONS

MILITARY

MIL-R-39008 Resistors, Fixed, Composition (Insulated),
Established Reliability, General Specification For.

HANDBOOKS

MILITARY

MIL-HDBK-217 Reliability Prediction of Electronic Equipment.

MIL-HDBK-251 Reliability/Design Thermal Applications.

(Unless otherwise indicated, copies of the military specification and handbooks are available from the Naval Publications and Forms Center. (ATTN: NPODS), 5801 Tabor Ave, Philadelphia, PA 19120-5099.)

30. DEFINITIONS

30.1 Definitions. The definitions of the terms used in performance of the failure rate calculation are described in the general requirements of MIL-HDBK-217.

40. GENERAL REQUIREMENTS

40.1 General. SHARP has adopted the MIL-HDBK-217 "Part Stress Analysis" method as a common basis for failure rate predictions of SEM. The failure rate predictions shall be made based upon the thermal performance prediction and shall be made with the following common MIL-HDBK-217 model data:

- (a) Environment - Ground Benign and Intended Use Environment (in the event that an intended use is not known, a series of three predictions shall be run utilizing the Ground Benign, Naval Sheltered, and one Airborne application).
- (b) Ambient temperature - Maximum class temperature (the temperature rise used in the piece part models shall be the temperatures submitted in the thermal performance analysis described herein).

40.2 Required information. As a minimum, the following information shall be supplied as part of the thermal prediction and failure rate prediction. The predictions shall be submitted to the SEM-QAA for approval prior to critical design review or equivalent review. A module thermal test shall be performed when the thermal prediction indicates that one or more component junction temperatures is greater than the maximum allowable CCT less 10°C.

40 2.1 Cover sheet. Cover sheets shall include military part number, the module key code, the date the prediction or analysis was submitted, the name of the module designer (manufacturer), MIL-HDBK-217 revision letter, and the company point of contact with telephone number.

40 2.2 Thermal prediction (analytical). The following information shall be part of the thermal prediction (figures provided as samples only).

- (a) Procedural flow chart (see figure 46)
- (b) Part description and quantity (military and generic part numbers) (see figure 47).
- (c) Detail specification for custom part numbers.
- (d) Component layout (must be cross referenceable to the parts list) (see figure 48).
- (e) Derating criteria used and component power dissipation.
- (f) Component junction to case thermal resistance.
- (g) Model used (see figure 49).
- (h) Calculated model thermal resistance values (with examples).
- (i) Method of cooling (fin or rib cooling for all module formats and air impingement cooling for all module formats except format A).
- (j) Prediction results with thermal interface at maximum class temperature (see figure 50).

40.2.3 Failure rate prediction. The following information shall be a part of the failure rate prediction (figures provided as samples only).

- (a) Procedural flow chart (see figure 46).
- (b) Part description and quantity (military and generic part numbers) (see figure 47).
- (c) Detail specification for custom part numbers.
- (d) Component layout (must be cross referenceable to the parts list) (see figure 48).
- (e) Derating criteria used and component power dissipation.
- (f) All MIL-HDBK-217 model inputs and work sheets. Particular emphasis should be given to the following:
 - (1) Component junction temperatures.
 - (2) Component junction to case thermal resistance.

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- (3) All pi factors for the MIL-HDBK-217 model used (including the quality factor used).
 - (4) Component voltage and current stresses shall be actual design derated value that the component experiences in operation.
 - (5) Component power dissipation.
- (g) Supporting references.
- (h) Module summary sheet with prediction results (see figure 50).

40.2.4 Thermal test (empirical). The following information shall be part of the thermal test (figures provided as samples only):

- (a) Procedural flow chart (see figure 46).
- (b) Part description and quantities (military and generic part numbers) (see figure 47).
- (c) Component layout (must be cross referenceable to the parts list) (see figure 48).
- (d) Test method with circuit diagram (see figure 52).
- (e) Component junction to case thermal resistance.
- (f) Method of cooling (fin, rib or air impingement cooling).
- (g) Analysis results with thermal interface at maximum class temperature.

40.3 Parts derating. Electrical parts shall not be stressed more than the percentage of their rated value specified in table XII, when operated in accordance with the CCT and TCCT tests for the appropriate module class temperature. Electrical parts which are stressed more than the indicated percentages shall have been approved by the SEM-QAA prior to their use.

40.4 Module changes. Any component, layout, or assembly changes to the module which appreciably affect the failure rate prediction or the module thermal performance shall require a resubmission of the thermal prediction and failure rate prediction to the SEM-QAA.

40.5 Piece part failure rates. The supplier shall submit detailed information on the failure rate derivation of any printed-wiring board, substrate, or component which is not modeled in MIL-HDBK-217.

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TABLE XII. Parts derating.

Part type	Derating parameter	Derated to percent of rated
Resistors		
Carbon composition	Power/voltage	50/80
Film high stability	Power/voltage	50/80
Wirewound accurate	Power/voltage	50/80
Wirewound chassis mounting	Power/voltage	50/80
Variable wirewound	Power/voltage	50/80
Variable non-wirewound	Power/voltage	50/80
Thermistor	Power/voltage	50/80
Tantalum nitride chip	Power/voltage	50/80
Capacitors		
All	Ripple voltage or ripple current	70
Ceramic	Voltage	50
Glass	Voltage	50
Mica	Voltage	60 dipped 40 molded
Plastic	Voltage	50
Mylar	Voltage	50
Paper	Voltage	50
Tantalum solid (100% current surge test required)	Voltage	50
	Reverse voltage	2% of rated DC up to 85°C
	Reverse voltage	1% of rated DC from 85 to 125°C
Tantalum wet	Voltage	60
	Reverse voltage	0
Tantalum foil	Voltage	60
Aluminum electrolytic (resin end-seal protection and 99.96 percent Al foil purity)	Voltage	75
	Reverse voltage	0

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TABLE XII. Parts derating - Continued.

Part type	Derating parameter	Derated to percent of rated
Switches	Contact current	75
	Voltage	50
Connectors	Contact current	50
	Voltage (dielectric withstanding)	25
Magnetic devices	Current density	2.0 mA per circular mil
	Current density (foil conductors)	8.0 mA per square mil
	Voltage (continuous)	60
	Voltage (surge)	90
	Hot spot temperature (operating)	75
	Insulation breakdown voltage	25
RF coils	Current	50
Relays	Contact power	25
	Contact current	50 resistive 25 inductive
	Contact current (surge)	80
	Coil energize/drop-out voltage	vendor's nominal rating
	Vibration	75 with Q of mounting

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TABLE XII. Parts derating - Continued.

Part type	Derating parameter	Derated to percent of rated
Transistors Bipolar, power and FET	Power ^{1/} Forward current (continuous) Forward current (surge) Voltage (steady state) Transient peak voltage	50 50 60 75 across any junction 80 across any junction
Diodes Switching, general purpose, and rectifier	Current (surge) Current (continuous) Peak inverse voltage Current (surge) Current (continuous)	70 50 65 70 50
Microcircuits All linear	Current (continuous) Current (surge) Voltage (signal) Voltage (surge) Voltage reverse junction (signal) Voltage reverse junction (surge) Supply voltage	70 60 75 80 65 85 Vendor's nominal rating
Digital ^{2/}	Fanout	80

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TABLE XII. Parts derating - Continued

Part type	Derating parameter	Derated to percent of rated
Fuses	Current	25

- 1/ The maximum ratings as determined by the safe operating area (SOA) curves for power switching transistors shall not be exceeded.
- 2/ Many families of digital microcircuits exhibit additional characteristics that may require derating (for example, toggle frequency hold times).

40.6 Application. As a minimum, the SEM failure rate predictions shall be performed at Ground Benign and intended use environments using maximum class temperatures. In the event that an intended use environment is unknown, the failure rate prediction shall be performed at Ground Benign, Naval Sheltered, and one Airborne application.

40.7 Component temperature. The failure rate prediction shall be performed using as a minimum, the worse case component junction temperatures obtained from the thermal prediction. The results of either the fin or rib cooling prediction (at maximum class temperature), whichever yields the hottest component temperatures, shall be used.

50. DETAILED REQUIREMENTS

50.1 Failure rate prediction. The following information is required for the SEM failure rate prediction.

50.1.1 Basis for failure rate prediction. The failure rate prediction shall reflect the following:

- (a) The temperatures submitted with the module thermal prediction
- (b) Maximum stresses as specified in the detail specification.
- (c) Intended use environment (see 30.1).
- (d) Maximum class temperature.

50.1.2 Printed-boards. The board failure rate is a summation of failure rates for the solder connections of the connector (contacts), soldering of plated-through holes, and solder connection of piece-parts. MIL-HDBK-217 lists solder connection failure rates in the interconnection assemblies and connections section.

50.1.3 Module connector contact tail solder joint. Module connector contact tail solder joint failure rates shall be considered in SEM failure rate calculations.

50.1.4 Failure rate prediction techniques. The "part stress analysis" method of MIL-HDBK-217 is the authorized method for use for the prediction of failure rates for SEM. Any deviation from MIL-HDBK-217 requires prior approval of the SEM-QAA.

50.1.4.1 SEM prediction calculation. The failure rate of the specified SEM shall be calculated as follows:

- (a) Add all applicable piece part failure rates.
- (b) Add all applicable printed-board and connection failure rates.
- (c) Add the failure rates in a and b to derive the total module failure rate.

50.1.4.2 Supporting references. The supporting references shall include failure rate data if the part is not in MIL-HDBK-217. Any references other than MIL-HDBK-217 (manufacturer's piece part specifications, new prediction techniques, special stresses, and so forth) which provide quantitative data for the prediction shall be submitted

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50.1.5 Hybrid microcircuits. The hybrid microcircuit portion of MIL-HDBK-217 shall be followed to calculate the failure rate of a hybrid microcircuit.

50.1.6 Piece parts (other than hybrid microcircuits). The general procedure for determining piece part failure rates shall be as follows:

- (a) List each piece part on a work sheet. Be sure that all of the parts in the module are accounted for and that each part is completely identified.
- (b) Determine the required electrical stress ratio for each part listed. The value of 0.1 is a derating threshold below which little or no reduction in failure rate can be anticipated; therefore 0.1 is used as the minimum electrical stress ratio in the SEM approach to failure rate prediction. The stress ratio may be rounded off to the nearest tenth.
- (c) A stress value for each part must be determined to use the failure rate prediction techniques. The effects of duty cycles must be considered where higher stresses may contribute significantly to the failure rate, even if only for short periods of time. Consideration must be given to thermal time constants and cumulative heating effects. The stress levels which most closely approximate the most strenuous stress levels that the module will encounter shall be utilized in the failure rate prediction. Elements of discretion and sound engineering judgement must be exercised and each case analyzed separately.
- (d) Refer to the proper MIL-HDBK-217 prediction model for each part.
- (e) Derive appropriate multipliers and factors.
- (f) Apply these multipliers and factors to the proper model to obtain a failure rate for each part.

50.1.7 Piece part work sheet(s). The piece part work sheet(s) shall include the nomenclature of the component as it appears on the module summary sheet, the mathematical prediction model used in the prediction, the paragraph or section of the reference used, a list of the appropriate

failure rate modifiers, the assumptions and references from which the modifiers were chosen, and a failure rate for the piece part expressed in failures per million hours. The piece part work sheet(s) shall be in the formats shown in figures 53 through 56.

50.1.8 Module summary sheet. The module summary sheet shall include the name of the individual piece parts (components), the quantity in the module, the individual piece part failure rate, the reference from which the prediction was made, and the module failure rate expressed in failures per million hours. The module failure rate may be rounded off to the nearest thousandth. The module summary sheet shall be in the format shown in figure 51.

50.2 Thermal performance. Thermal performance shall be determined in accordance with the following methods.

50.2.1 Thermal prediction. The preferred thermal prediction method is finite element analysis. However, other prediction methods, such as nodal analysis, are acceptable provided that the method used yields results that are comparable to the actual measured temperatures. MIL-HDBK-251 may be used as a guide to perform this prediction.

50.2.1.1 Node locations. A sketch shall be included that shows the approximate locations of the nodes used to perform the thermal prediction. An example sketch is shown on figure 57.

50.2.1.2 Thermal network. The module thermal model network with individual nodes identified shall be included as a part of the thermal prediction. An example module thermal network is shown on figure 49.

50.2.1.3 Model resistances. The thermal prediction shall contain a table stating the calculated thermal resistance values for the thermal model network (see figure 50).

50.2.1.4 Calculations. Example calculations shall be included of individual thermal resistance determinations

50.2.2 Thermal test. The module thermal test shall be performed on an engineering module or production equivalent module constructed of the same materials and components to be used on the final product. Component locations shall be the same as expected to be used for the final product.

50.2.2.1 Test conditions. A diagram of the module test circuit used to exercise the module shall be included in the analysis documentation submitted for SEM-QAA approval.

50.2.2.2 Thermal isolation. The module under test shall be insulated in a manner to force the entire module cooling through either the module fin or module rib depending on the test being performed. The fin and rib cooling tests must be performed independently.

50.2.2.3 Preferred operation. The thermal analysis shall be operated in accordance with the component temperature test as described in the appropriate MIL-M-28787 associated detail specification if it exists. The module shall be operated at the appropriate maximum class temperature for a period of at least one hour prior to recording temperature data

50.2.2.4 Equivalent tests. In lieu of performing the thermal tests described in 50.2.2.1 and 50.2.2.2, a computer generated simulation may be submitted. The computer generated simulation must be validated using empirical data and the validation approved by SEM-QAA.

50.2.3 Power dissipation. Individual component power dissipations used for the thermal performance prediction and thermal analysis shall be the maximum expected power dissipation for the component when the module is operated under worst case electrical conditions as defined in the module MIL-M-28787 associated detail specification.

50.2.4 Parts list. A list of the individual parts used on the module and within the individual hybrid devices shall be included. The parts list shall identify the parts by military (and generic part number, if one exists) and shall be readily referenceable to the module assembly layout (see figure 47).

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50.2.5 Module assembly layout. A sketch shall be included of the module assembly layout. Components on the layout shall be readily identifiable to the module parts list (see figure 48).

50.2.6 Component junction to case thermal resistances The individual component junction to case thermal resistances shall be stated for all hybrid and microcircuit devices.

50.2.7 Cooling interface temperature. Both the module thermal prediction and test shall be performed with the cooling interface held at the appropriate maximum class temperature. The prediction and test shall be performed for both fin and rib cooling conditions.

60. NOTES

60.1 Data rights. All data specified to be delivered or subject to order in accordance with this appendix shall be furnished for Government use only.

60.2 Failure rate prediction information. SEM failure rate predictions for MIL-HDBK-217 environments other than ground benign and maximum class temperature may be obtained by contacting the SEM-QAA.

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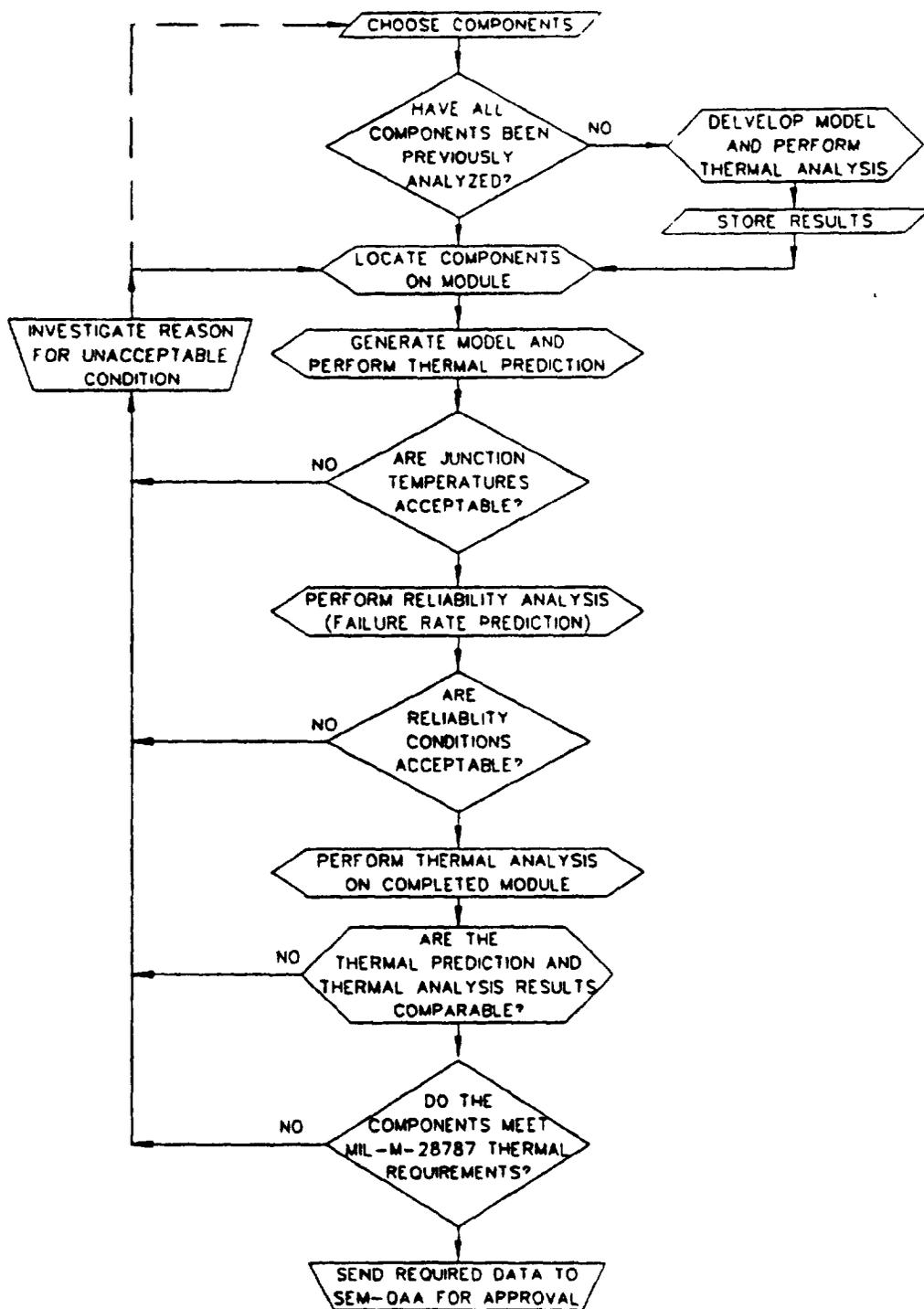


FIGURE 46. Procedural flow chart example.

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PARTS LIST		PREPARED: 23 MAY 1985	
QUAN	PART NUMBER	NOMENCLATURE	REF NO
1	M39003/01-2523	CAPACITOR, 2.2 μ F	C1
2	M39014/05-2048	CAPACITOR, 3900 pF	C2,C3
3	54LS112	DUAL JK FLIP-FLOP 16 pin DIP	U1,U2,U3
2	RLR07C1001FM	RESISTOR 1K Ω	R1,R2
1	M28754/12-01	FRAME/CONNECTOR ASSEMBLY, 40 PIN	

FIGURE 47. Parts list example.

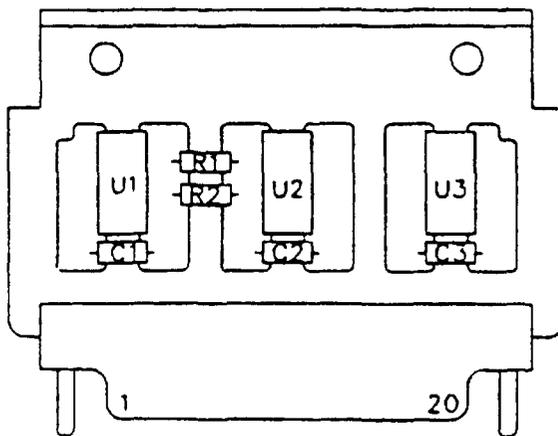


FIGURE 48. Example component layout.

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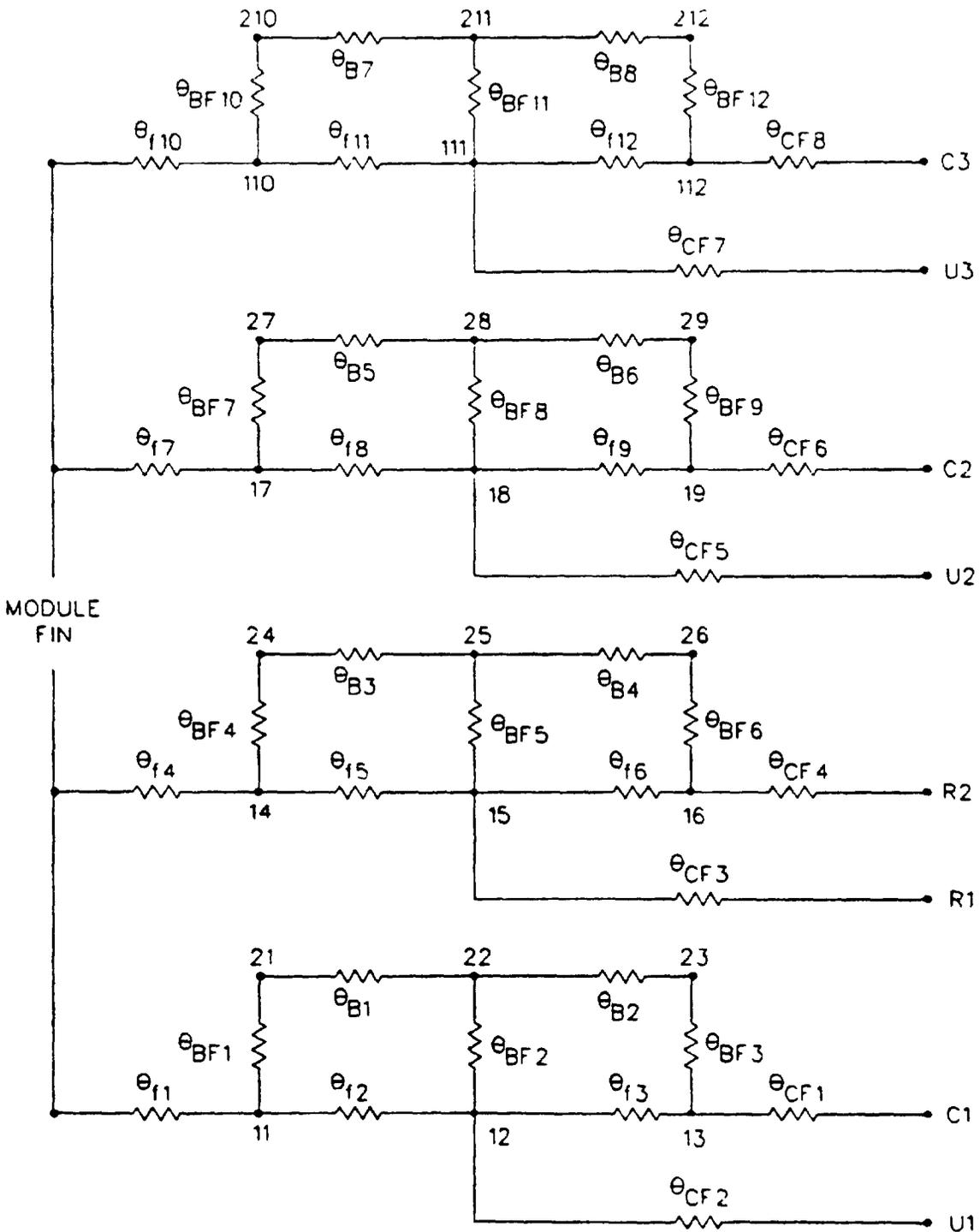


FIGURE 49. Example of fin cooling thermal network model.

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THERMAL PREDICTION RESULTS
(ALL TEMPERATURES ARE DEGREES C)

RIB COOLING:

RIB TEMPERATURE	COMPONENT	CASE TEMP	θ_{JC}	JUNCTION TEMP
60	U1	70.4	32	75.7
	U2	74.6	32	79.9
	U3	71.2	32	76.5
	R1	63.7	--	--
	R2	64.3	--	--
	C1,C2,C3	62.3	--	--

FIN COOLING:

FIN TEMPERATURE	COMPONENT	CASE TEMP	θ_{JC}	JUNCTION TEMP
60	U1	68.2	32	73.5
	U2	69.1	32	74.4
	U3	68.5	32	73.8
	R1	61.1	--	--
	R2	61.3	--	--
	C1,C2,C3	62.0	--	--

FIGURE 50. Example results of thermal prediction.

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MODULE FAILURE RATE SUMMARY SHEET
(GROUND BENIGN)

QTY/TEMP	PART NUMBER	TEMP	SCREENING
1 CAP	M39003/01-2523	62	MILSPC STRESS=0.500 PIE=1.000 PIQ=0.300 PISR=0.330 PICV=1.099 BASE F.R.=0.19220391E-01 F.R.=0.20916457E-02
2 CAP	M39014/05-2048	62	MILSPC STRESS=0.500 PIE=1.000 PIQ=0.100 PICV=1.020 BASE F.R.=0.39187763E-02 F.R.=0.39898025E-03
1 IC-	54LS112	76	B-1HDG PIV=1.000 PIL=1.000 PIQ=2.000 PIT=1.7137 PIE=0.380 C1=0.010000 C2=0.005922 F.R.=0.0388
1 IC-	54LS112	77	B-1HDG PIV=1.000 PIL=1.000 PIQ=2.000 PIT=1.7969 PIE=0.380 C1=0.010000 C2=0.005922 F.R.=0.0404
1 IC-	54LS112	80	B-1HDG PIV=1.000 PIL=1.000 PIQ=2.000 PIT=2.0684 PIE=0.380 C1=0.010000 C2=0.005922 F.R.=0.0459
2 RES	RLR07C1001FM	64	MILSPC STRESS=0.500 PIE=1.000 PIQ=1.000 PIR=1.000 PIT=1.00 BASE F.R.=0.69000002E-04 F.R.=0.15553810E-02
98 INT	WAVE_SOLDER		PIE=1.000 PIQ=1.00 PIC=1.00 BASE F.R.=0.41000000E-04 F.R.=0.41000000E-04

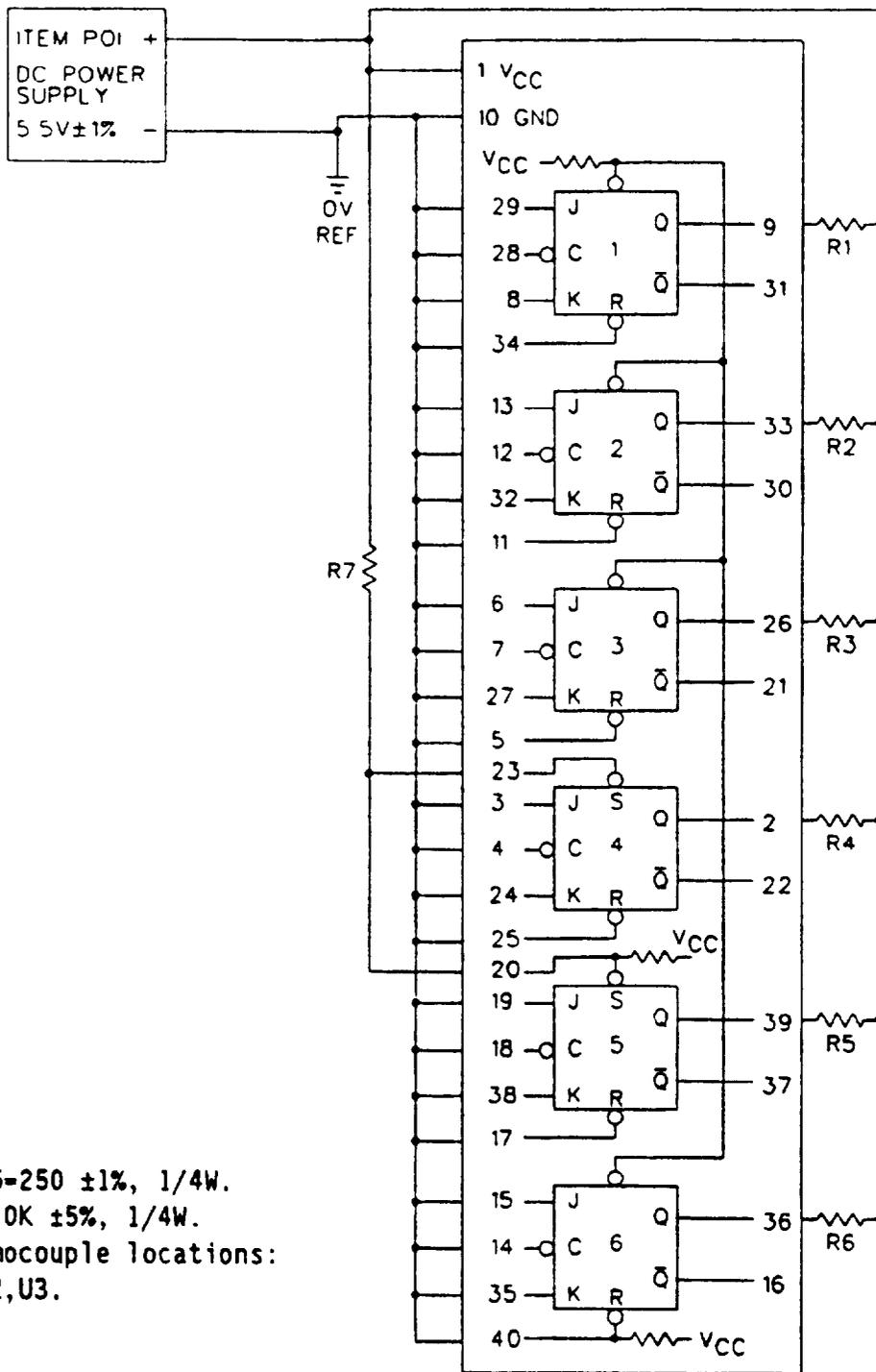
TOTAL FAILURE RATE FOR XXX MODULE = 0.135120E+00 FAILURES PER MILLION HOURS

NOTE: Piece part failure rates (F.R.) given above are for a quantity of one. To obtain the total piece part failure rate for quantities greater than one, multiply the quantity by the indicated piece part failure rate.

Temperatures given for IC devices are the component junction temperature. For all other devices, the temperature listed is the component case temperature.

FIGURE 51. Example module failure rate summary sheet.

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NOTES:

1. R1-R6=250 ±1%, 1/4W.
2. R7=1.0K ±5%, 1/4W.
3. Thermocouple locations:
U1,U2,U3.

FIGURE 52. Example component temperature test circuit.

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Component: Hybrid microcircuit, driver.

Math model: $\lambda p = (\sum N_C \lambda_C \Pi_G + [N_R \lambda_R + \sum N_I \lambda_I + \lambda_S] \Pi_F \Pi_E) \Pi_Q \Pi_D$

Reference: MIL-HDBK-217.

λ/Π	Assumptions/references
$\Pi_Q \Pi_L (C_1 \Pi_T \Pi_V + C_2 \Pi_E) \Pi_G =$ $(1.0)(1.0) [(0.01)(8.3)(1.0) +$ $(0.0)(0.38)] (1) =$ <p>0.08300</p>	<p>(1) LM106 die, 13 transistors. (2) Acquired to MIL-M-38510, class B. (3) Junction temperature = 83°C (from thermal analysis). (4) Environment = G_B.</p>
$\Pi_Q \Pi_L (C_1 \Pi_T \Pi_V + C_2 \Pi_E) \Pi_G =$ $(1.0)(1.0) [(0.01)(9.2)(1.0) +$ $(0.0)(0.38)] (1) =$ <p>0.09200</p>	<p>(1) μA741 die, 23 transistors. (2) Acquired to MIL-M-38510, class B. (3) Junction temperature = 89°C (from thermal analysis). (4) Environment = G_B.</p>
$\lambda_b (\Pi_E \Pi_A \Pi_Q \Pi_R \Pi_{S2} \Pi_C) \Pi_G =$ $0.0029 [(1.0)(1.5)(0.12)(1.0)(0.88)(1.0)]$ <p>0.4 = 0.00018</p>	<p>(1) Si NPN transistor die (2 each). (2) JANTXV. (3) 60% power and voltage stress ratio. (4) Environment = G_B. (5) Linear application <1 watt</p>

FIGURE 53. Sample piece part work sheet (hybrid).

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λ/Π	Assumptions/references
$\lambda_b (\Pi_E \Pi_A \Pi_Q \Pi_R \Pi_{S2} \Pi_C) \Pi_G =$ $0.0049 [(1.0)(1.5)(0.12)(1.0)(0.88)(1.0)$ $(0.88)(1.0)] 0.4 =$ 0.00027	(1) Si PNP transistor die (2 each). (2) JANTXV (3) 60% power and voltage stress ratio. (4) Environment = G_B (5) Linear application <1 watt
$\lambda_b (\Pi_E \Pi_Q \Pi_R \Pi_A \Pi_{S2} \Pi_C) \Pi_G =$ $0.0019 [(1.0)(0.15)(1.0)(1.0)(0.7)(1.0)]$ $0.2 = 0.00004$	(1) Si general purpose diode die (2 each). (2) JANTXV. (3) 60% power and voltage stress ratio. (4) Environment = G_B . (5) Small signal metallurgically bonded. (6) Analog application.
$\lambda_b (\Pi_E \Pi_Q \Pi_{CY}) \Pi_G =$ $0.0063 [(1.0)(0.3)(0.9)] 0.8 =$ 0.00136	(1) Ceramic chip capacitor (2 each). (2) CKR05. (3) 60% stress ratio. (4) 1,000 μF . (5) Failure rate level P.
$\lambda_R = 0.00015$	(1) Thick film resistors (17 each). (2) Hybrid package temperature = 65°C.
$\lambda_I = 0.00130$	(1) Au - Al Interconnections (34 each). (2) Package temperature = 65°C

FIGURE 53. Sample piece part work sheet (hybrid) - Continued

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λ/Π	Assumptions/references
$\lambda_I = 0.00087$	(1) Solder interconnections (34 each). (2) Package temperature = 65°C
$\lambda_S = 0.108$	(1) Seal perimeter = 4.2 inch (2) Package temperature = 65°C
$\Pi_F = 1.25$	(1) Linear application.
$\Pi_E = 0.20$	(1) Environment = G _B .
$\Pi_Q = 1.0$	(1) Acquired to MIL-M-38510, class B.
$\Pi_D = 1.34$	(1) 38 interconnections. (2) 0.75 x 0.75 inch substrate. (3) Density = 38/(0.563 + 0.10) = 57.3.

$$\lambda_p = \{0.08300 + 0.09200 + 2(0.00018) + 2(0.00027) + 2(0.00004) + 2(0.00136) + [17(0.00015) + 34(0.00130) + 4(0.00087) + 0.108] (1.25)(0.20)\} (1.0)(1.34).$$

$$= \{0.17870 + (0.15823) (0.25)\} (1.34) = 0.29247 \text{ failures}/10^6 \text{ hours.}$$

FIGURE 53. Sample piece part work sheet (hybrid) - Continued.

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Component Solid tantalum capacitor, MIL-C-39003.

Math model: $\lambda_p = \lambda_b(\Pi_E \Pi_{SR} \Pi_Q \Pi_{CV})$.

Reference: MIL-HDBK-217

λ/Π	Assumptions/references
$\lambda_b = 0.028$	(1) Stress ratio = applied voltage/rated voltage = 40/75 = 0.53 (2) Temperature = 75°C (from thermal analysis). (3) Interpolate for 75°C and 0.53 stress ratio.
$\Pi_E = 1.0$	(1) Environment - G _B .
$\Pi_{SR} = 0.1$	(1) Ohms = 80. (2) Applied voltage = 40. (3) Ohms/applied voltage = 2.
$\Pi_Q = 0.1$	(1) Failure rate level R.
$\Pi_{CV} = 1.0$	(1) Capacitance = 1.1 μ F.

$\lambda_p = 0.028 [(1.0)(0.1)(0.1)] = 0.00028 \text{ failures}/10^6 \text{ hours.}$

FIGURE 54. Sample piece part work sheet (capacitor).

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Component: Fixed composition resistor, MIL-R-39008.

Math model. $\lambda_p = \lambda_b (\Pi_E \Pi_R \Pi_Q)$.

Reference: MIL-HDBK-217

λ/Π	Assumptions/references
$\lambda_b = 0.0012$	(1) Rated at 0.5 watts. (2) 0.2 watts applied. (3) Stress ratio = power applied/rated power = $0.2/0.5 = 0.4$. (4) Temperature = 60°C (from thermal analysis).
$E = 1.0$	(1) Ground, benign as specified by SEMP
$R = 1.0$	(1) 12 000 ohms.
$Q = 0.1$	(1) Failure rate level R.

$$\lambda_p = 0.0012 [(1.0)(1.0)(0.1)] = 0.00012 \text{ failures}/10^6 \text{ hours.}$$

FIGURE 55. Sample piece part work sheet (resistor).

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Solder connections, hand soldered.

MATH MODEL: $\lambda_b \times \Pi_Q \times \Pi_E \times (\Pi_C + 13)$

40 pin connector

$40 \times 0.000574 = 0.02296$ failures per 10^6 hours

Solder connections, wave soldered

MATH MODEL: $\lambda_b \times \Pi_Q \times \Pi_E \times \Pi_C$

Seven solder filled plated through holes - 7

Two 24 contact IC's - 48

Four 2 lead capacitors - 8

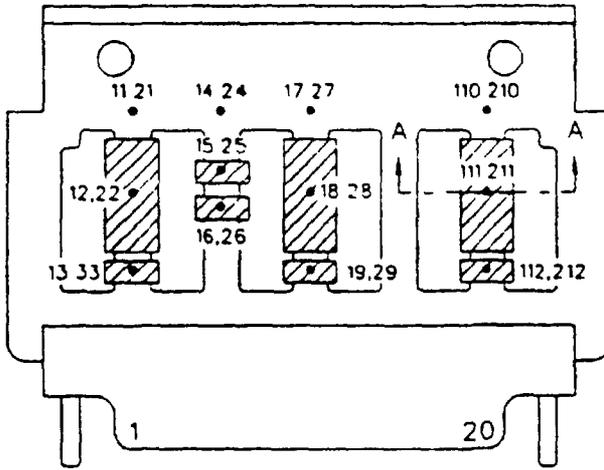
Two 2 lead resistors - 4

Total - 67

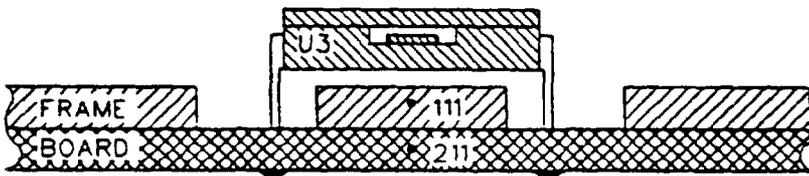
Therefore: $67 \times 0.000041 = 0.002747$ failures per 10^6 hours

FIGURE 56. Sample piece part work sheet (solder connection).

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Approximate node locations.



Section A-A

FIGURE 57. Example sketch showing node locations.

APPENDIX H

REQUIREMENTS FOR PRINTED-BOARD ASSEMBLIES
USED IN STANDARD ELECTRONIC MODULES

10 SCOPE

10.1 Scope. This appendix is a mandatory part of the standard for the design requirements for printed-board assemblies used in SEM. The information contained herein is intended for compliance. For the purpose of this document, "printed-board assemblies" will include board assemblies of both epoxy and ceramic.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standards. The following specification and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issue 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.

SPECIFICATIONS

MILITARY

MIL-F-14256	-	Flux, Soldering , Liquid (Rosin Base)
MIL-I-46058	-	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)

STANDARDS

MILITARY

MIL-STD-105	-	Sampling Procedures and Tables for Inspection by Attributes
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MIL-STD-2000 - Soldering Technology, High
Quality/High Reliability

(Unless otherwise indicated, copies of the military specifications and standards are available from the Naval Publications and Forms Center (ATTN: NPODS), 5801 Tabor Ave, Philadelphia, PA 19120-5099.)

20 2 Non-Government publications. The following document forms a part of this appendix 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.

INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

T-50 - Terms and Definitions for
Interconnecting and Packaging
Electronic Circuits.

(Applications for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Ave, Lincolnwood, IL 60646.)

(Nongovernment standards 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.)

30. DEFINITIONS

30.1 Terms and definitions. Terms and definitions shall be in accordance with IPC-T-50.

30.2 Component. A component is a part or combination of parts performing a design function. Components include the module connector, the test point header, leaded surface mount parts, leadless surface mount parts, and through holes leaded parts.

40 GENERAL REQUIREMENTS

40.1 Design features. The design features of printed-board assemblies shall be in accordance with this appendix.

40.2 Materials. Materials used in the fabrication of printed-board assemblies shall conform to the requirements specified herein.

40.2.1 Printed-boards. Printed-boards shall be in accordance with this standard.

40.2.2 Solder processes and processing. Solder processes, processing and processing materials shall be in accordance with MIL-STD-2000.

40.2.3 Component parts. Component parts mounting shall be in accordance with MIL-STD-2000.

40.2.4 Soldered connections. Solder connections shall be in accordance with MIL-STD-2000 requirements.

40.2.5 Welded connections. Welded connections shall not exhibit damage (that is, melting of the epoxy base laminate) caused by incorrect weld schedules. Welds shall be free of pits, surface flashes, tip pickup, cracks, edge bulge, blown spots, foreign particle inclusions, and lack of fusion which may degrade printed-board assembly performance.

40.2.6 Repair and rework. The rework of defective solder connections and the replacement of defective parts shall be permissible providing the rework is performed in accordance with MIL-STD-2000 and does not degrade the mechanical, electrical, or physical properties of the printed-board assembly. Repairs shall not be made to broken or otherwise damaged conductor paths on the printed-board and assembly.

40.2.7 Physical dimensions and features. The printed-board assembly shall be in accordance with the manufacturer's applicable printed-board assembly drawing. In addition, the location of all interfacial connections, parts, and so forth, shall be in compliance with the manufacturer's printed-board assembly drawing.

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40.3 Material review board (MRB) decisions. MRB decisions are limited as specified in MIL-M-28787.

50. DETAIL REQUIREMENTS

50.1 Rivets. Tubular rivets (including eyelets and semi-tubular rivets used for mechanical attachment) shall be free of obvious damage and circumferential cracks and splits. Radial cracks or splits must not extend into the barrel of the rivet. No more than three radial cracks per rivet are allowed provided that they do not intersect. No more than one split is allowed, provided that there are no other cracks in the rivet and the maximum separation of the split is less than 0.015 inches (0.381 mm). Rivets shall be tightly secured and exhibit proper rollover (see figure 58). The barrel of the rivet shall be free of contamination including solder and flux.

50.2 Metallic surfaces. Metallic surfaces shall be free of burrs, cracks, and sharp edges. Voids, blowholes, fissures, or porosity that is discernible by the unaided eye shall not exceed 0.010 inch (0.254 mm) deep by 0.030 inch (0.762 mm) diameter or 10 percent of the total metallic surface area. Scratches on anodized aluminum surfaces shall be painted to match the finish color. Scratches on other metallic surfaces shall be repaired utilizing a protective coating that will guard against corrosion and will match the finish color. NiCad finish will be used on copper frames. The area of repair shall not exceed 5 percent of the total metallic surface area.

50.3 Nonmetallic surfaces. Nonmetallic surfaces shall be free of cracks, foreign material, and sharp or rough edges. Voids, blisters, pinholes, or mold marks shall not exceed 10 percent of the total nonmetallic surface area. The maximum concentration of defects shall not exceed 5 percent of nonmetallic surface area.

50.4 Encapsulation and bonding. Encapsulation and bonding shall be in accordance with the following requirements.

50.4.1 Encapsulation Encapsulants used on printed-board assemblies shall be continuous, homogenic, fully cured and shall cover all components, leads, and circuits specified on the printed-board assembly drawing. Pits, pinholes, or voids not exceeding 0.010 inch (0.254 mm) deep by 0.030 inch (0.762 mm) diameter or scratches not exceeding 0.020 inch (0.508 mm) wide by 0.500 inch (12.700 mm) long and 0.010 inch (0.254 mm) deep are permissible provided that components and circuitry are not exposed. Maximum concentration of defects shall not exceed 10 percent of the total nonmetallic surface area.

50.4.2 Bonding. Adhesives or bonding agents used on printed-board assemblies shall be continuous, tack free and fully cured showing no evidence of flaking, chipping, blistering, or peeling from the base material. There shall be no striations or cracks in the adhesive. There shall be no voids or group of voids greater than 5 percent of the visual adhesive area. Bubbles are permissible provided there is no loss of bond strength.

50.5 Leadless component mounting. Leadless components shall be mounted to the terminal areas on printed-boards in accordance with the following paragraphs.

50.5.1 Leadless parts. Parts specifically designed for surface mount applications may be attached to terminal areas on printed-boards. For LCCs: the printed-board solder land shall extend under the LCC the same distance as the metallization on the underside of the LCC; the printed-board solder land shall have at least the same width as the metallization on the underside of the LCC; the printed-board solder land shall extend 0.015 inch (0.381 mm) minimum beyond the LCC (not including the added distance due to the castellation). For leadless chip capacitors and chip resistors the printed-board solder land shall extend a minimum of 0.015 inch (0.381 mm), or the same distance beyond the chip as the metallization on the underside of the chip, depending on which dimension is the smaller; the printed-board solder land shall have enough width beyond the width of the chip to allow for proper solder wetting on the sides of the chip metallized terminations (see figure 59). Designs to utilize parts which do not have metallization on the sides are not required to have printed-board

solder land width beyond the part edges. Leadless parts shall have an average maximum spacing of 0.002 inch (0.051 mm) to an average maximum spacing of 0.015 inch (0.381 mm) between part body and the printed-board. Leadless part solder joints shall be designed for a maximum service environment solder strain level of 0.005

50.5.2 Leadless part alignment. Leadless parts shall be aligned as specified in MIL-STD-2000 except for the following items.

50.5.2.1 Metallized terminations. The metallized terminations of LCCs must align with printed-board lands with 75 percent minimum of the width of the metallized terminations (see figure 60). The chip component terminations shall not overhang the printed-board lands by more than 10 percent of the device termination width on any one side provided that minimum electrical spacing is maintained (see figure 61). In no case shall design clearances be exceeded.

50.5.2.2 Chip lap. The end cap of the chip device shall extend onto the terminal area a minimum of the same distance as the metallization on the underside of the chip (see figure 62).

50.5.2.3 Chip elevation. The space between the body of the soldered-in-place chip device and the terminal areas shall not be less than an average 0.002 inch (0.051 mm) and shall not exceed an average 0.015 inch (0.381 mm) (see figure 63).

50.5.3 Electrical clearance. The minimum spacing between leadless chips shall be 0.050 inch (1.270 mm).

50.5.4 Leadless device solder finish. Solder joints formed using vapor phase soldering will not be required to have a lustrous finish. The connection must exhibit 95 percent wetting and show no indication of a cold or rosinous solder joint as evidenced by the appearance of a dull grainy surface. No insulation material or other contaminants shall be included or imbedded in the solder. Refer to figures 64 through 67 for LCC requirements and figures 59, 61, and 68 through 70 for chip capacitor and

chip resistor requirements. Connections incorporating gold or gold plated elements shall conform to these same requirements except that the finish need not be lustrous and may be slightly porous. For special technologies, the visual inspection shall be performed at a minimum of ten power.

50.5.5 Method of soldering. The soldering process shall minimize solder grain size. Surface mount attachment of leadless components shall be hand soldered only when approval is obtained from the SEM-QAA prior to initial module qualification. Hand soldering during module rework does not require prior approval

50.6 Modifications to MIL-STD-2000. Listed below are requirements from MIL-STD-2000 that are modified for SEM. For SEM, any item requiring approval or concurrence by the Government Contracting Officer in MIL-STD-2000 shall also require approval by the SEM-QAA.

- (a) Task D: Hand soldering process controls. Manual soldering shall be accomplished using the requirements for materials and facilities, tools and equipment specified in MIL-STD-2000. Tools used in the soldering process shall be cleaned prior to use, be free of dirt, grease, flux, oil and other foreign matter, and be kept clean during use.
- (b) Cleanliness testing. After cleaning in accordance with paragraph 5.3.1, the printed-board assemblies, terminal boards, and electrical/electronic modules shall be subjected to a cleanliness test before the end of the production shift. The resistivity of solvent extract test, or the sodium chloride (NaCl) salt equivalent ionic contamination test, or a test approved by the Government Contracting Officer shall be used to test for ionic cleanliness. The resistivity of solvent extract test must have a final value greater than 2,000,000 ohm-centimeters. The sodium chloride salt equivalent ionic contamination test must have a final value less than 10.0 micrograms per square inch of board surface area. The board surface area of completed printed-board assemblies, terminal boards and electrical/electronic modules shall be understood to include the surface area of all component parts. One representative sample of each printed-board assembly

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(PBA) type processed during each production shift, shall be subjected to the cleanliness verification test. Each type of PBA shall consist of either the assemblies having the same part number or of different part numbered assemblies having the same size or assembly configuration using the same volume of resistivity solution. If the sample fails the cleanliness test, all lots represented by the failed sample shall be recleaned, retested and sampled, as a minimum, in accordance with MIL-STD-105, Inspection Level S-2, AQL-1.0 percent defective. Two subsequent lots shall be tested in accordance with MIL-STD-105 Inspection Level S-2, AQL-1.0 percent defective. Written evidence of the cleanliness tests shall be maintained by the supplier for a minimum of three years.

- (c) Conformal coating application. Conformal coating material shall be as specified on the Government approved assembly drawing. The material specification and manufacturer's instructions, as applicable, shall be followed and the material shall be used within the time period specified (both shelf-life and pot life). The coating shall be a minimum thickness (see (d)) and fillets shall be kept to a minimum consistent with the size, weight, and mounting provisions of the components. A continuous coating shall be applied to all external surfaces of the PBA, using either a brush, dip, spray or vacuum deposition method which is suitable to the particular assembly and within the MIL-STD-2000 requirements for conformal coating on adjustable components, brackets, flexible leads, and perimeter and edge coating. Conformal coating acceptance criteria is defined in 50.7 of this appendix.
- (d) Conformal coating thickness. When thickness is not specified on the Government approved assembly drawing or material or process specification, the coating thickness for conformal coating, as defined in MIL-I-46058 for Types AR, ER, and UR shall be 0.003 plus or minus 0.002 inch (0.076 plus or minus 1.930 mm). For Type SR, the coating thickness shall be 0.005 plus or minus 0.003 inch (0.127 plus or minus 0.076 mm). When Type XY is required by the approved assembly drawing, the coating thickness shall be 0.0012 to 0.002 inch (0.0031 to 0.076 mm). Thicknesses are measured on a flat unencumbered surface. For SEM, written evidence of the

specified conformal coat thickness (depending on the type used) must be maintained by the supplier for a minimum of 3 years. This evidence may be maintained on a sample basis utilizing actual hardware or a test coupon. Surfaces such as fins or other extensions which are necessary to ensure proper convective or conductive heat transfer from the printed-board assembly shall not be coated. In the absence of thermal shock test data demonstrating no stress cracking of the component or other adverse effects between the conformal coating and the parts and other materials used in the end item assembly, a suitable buffer material shall be provided between the conformal coating and glass diodes or other fragile part when coating type ER is used.

- (e) Jumper wires. Jumper wires included as a part of the initial design shall conform to the mounted requirements for axial leaded components and shall require approval by the SEM-QAA prior to initial qualification.
- (f) Wetting and filleting. Solder shall cover and blend smoothly to the substrate land or printed board terminal area and shall fillet to and blend smoothly with the metallized end cap. The solder connection must exhibit 95 percent wetting of the solderable area.
- (g) Lead seating for planar mounted flatpacks. Leads shall be seated such that the heel to terminal area relationship shall conform to figure 71. Leads shall be seated such that there is no side or heel overhang. Toe overhang is permissible provided that it does not exceed 0.005 inches (0.127 mm) for components and 0.030 inches (0.762 mm) for connectors (see figure 72) and the spacing to adjacent conductive elements remains greater than the minimums specified in requirements for rigid, flexible and rigid-flex printed-boards. Toe overhang (see figure 72) is acceptable provided that the other lead seating for planar mounted flat pack requirements of MIL-STD-2000 are met.
- (h) Planar mounted components. Except as specified in MIL-STD-2000 requirements for miniature axial lead components and flat packs of a plug in configuration, see MIL-M-28787 for information needed for design approval involving planar mounted components.

50.7 Conformal coating acceptance criteria The following criteria shall be used as conformal coating acceptance criteria in addition to the requirements stated in MIL-STD-2000. Minimum electrical spacing is defined herein to be 0.005 inches (0.127 mm) or the minimum electrical spacing defined on the assembly master drawing.

50.7.1 Bubbles in conformal coating. In no instance shall a bubble in the conformal coating result in less than minimum electrical spacing. This criteria applies to both single bubbles or a string or combination of bubbles, and may be used cumulatively. Bubbles shall be contained within the coating material. Foaming involving the majority of area between adjacent circuit areas is not permissible. Bubbles in unencumbered, noncircuit areas shall not, in combination, exceed 5 percent of the board area. Bubbles may not obscure identification markings.

50.7.2 Foreign material in conformal coating. In no instance shall foreign material in the conformal coating be longer than 0.030 inches (0.762 mm) in length. Particles of dried conformal coating material imbedded in or securely attached to the coating is not defined as foreign material and is permissible. Non-conductive particles, fibers, dust, and lint imbedded in or securely attached to the coating is acceptable as defined above. Fully visible conductive foreign material imbedded in or securely attached to the coating in circuit areas cannot reduce electrical spacing between adjacent circuit areas to less than minimum electrical spacing. Foreign material imbedded in or securely attached to the coating is acceptable in non-circuit areas, provided identification markings are not obscured. The total number of occurrences of foreign material and dried conformal coat particles shall not exceed ten per module side.

50.7.3 Conformal coating voids. Cumulatively, conformal coating voids shall not exceed 5 percent of the circuit board assembly area.

50.7.3.1 Conformal coating voids in non-circuit areas. Conformal coating voids are permissible in non-circuit areas provided they meet the following criteria:

- (a) The void is no closer than 0.005 inches (0.127 mm) (cumulatively) to any circuit area.

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- (b) The void does not exceed a 0.25 inch by 0.25 inch (6.35 mm by 6.35 mm), or equivalent, area.

50.7.3.2 Conformal coating voids on components. Conformal coating voids are permissible on the tops of hermetically sealed components provided they meet the following criteria.

- (a) The void is no closer than 0.005 inches (0.127 mm) (cumulatively) to any circuit area or metallized contact or orientation mark.
- (b) The voids are not greater than 0.030 inches (0.762 mm) in diameter or do not exceed greater than 10 percent of the component top surface area.

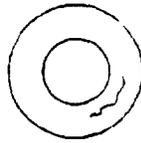
50.7.4 Other conformal coating criteria. A 10X magnification may be used as a referee inspection method. Conformal coating thickness variation resulting from rework are acceptable providing that the condition does not interfere with meeting module profile requirements and that coverage is evident.

50.8 Additional planar lead soldered connection criteria. The following criteria shall be used as planar lead soldered connection criteria in addition to the requirements stated in MIL-STD-2000.

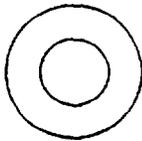
50.8.1. Planar lead solder fillet. Length and location of the lead shall be discernible within the solder. The maximum fillet shall not extend beyond the midpoint of the upper and lower lead bend radius. A fillet is not required at the heel or toe so long as the lead length contact of 150 percent of lead width exhibits good solder wetting.

50.8.2 Exposed basis metal. Exposed basis metal which results from the removal of a connector carrier strip is permissible.

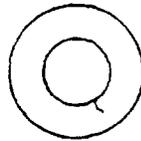
MIL-STD-1389D
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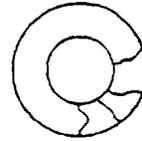
UNACCEPTABLE



ACCEPTABLE

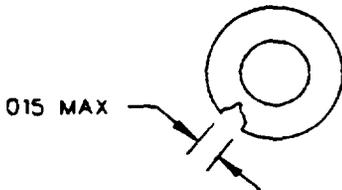


UNACCEPTABLE

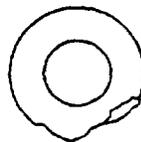


UNACCEPTABLE

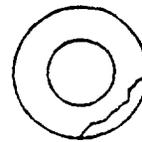
RADIAL CRACKS MUST NOT EXTEND INTO THE BARREL
NO MORE THAN THREE RADIAL CRACKS PER RIVET ARE ALLOWED



UNACCEPTABLE



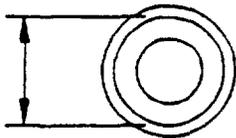
UNACCEPTABLE



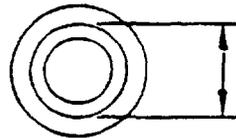
UNACCEPTABLE

NO MORE THAN ONE SPLIT PER RIVET IS ALLOWED
NO RADIAL CRACKS ARE ALLOWED WITH A SPLIT

ROLLOVER
DIAMETER $\geq 70\%$
OF RIVET HEAD
DIAMETER



ACCEPTABLE
ROLLOVER



ROLLOVER
DIAMETER OF
 $< 70\%$ OF RIVET
HEAD DIAMETER

UNACCEPTABLE
(LITTLE OR NO ROLLOVER)

FIGURE 58. Rivet inspection.

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PREFERRED

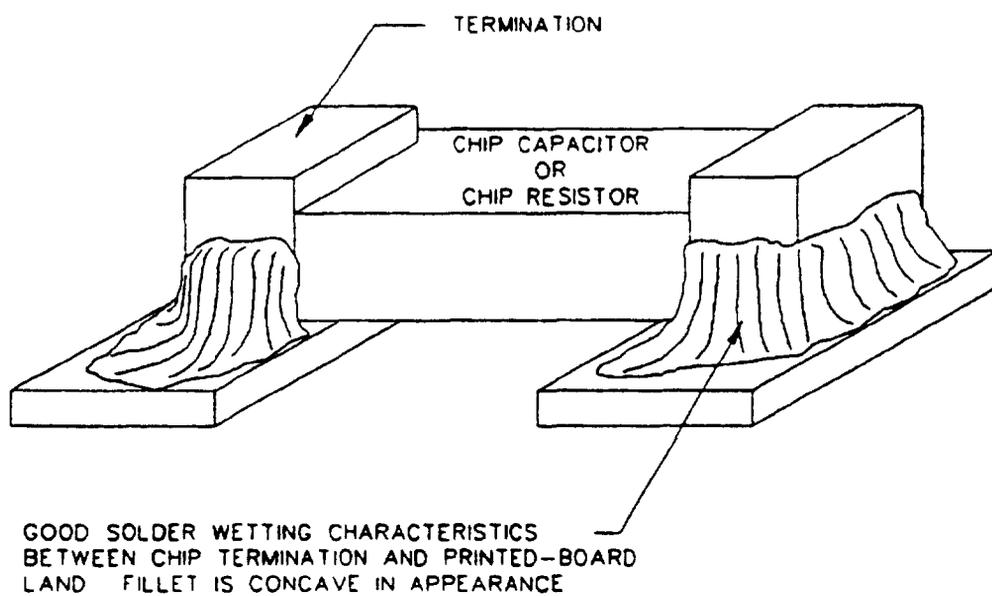
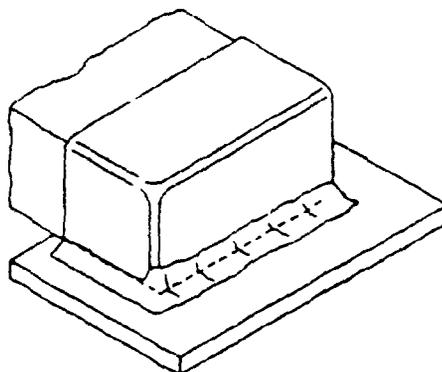


FIGURE 59. Leadless part solder wetting.

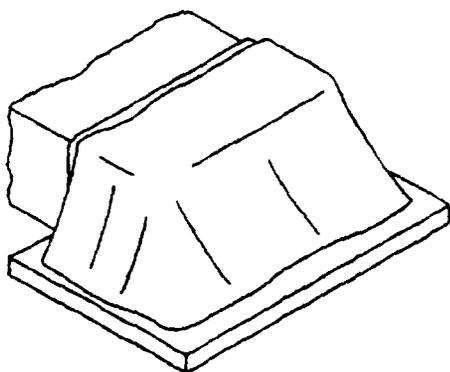
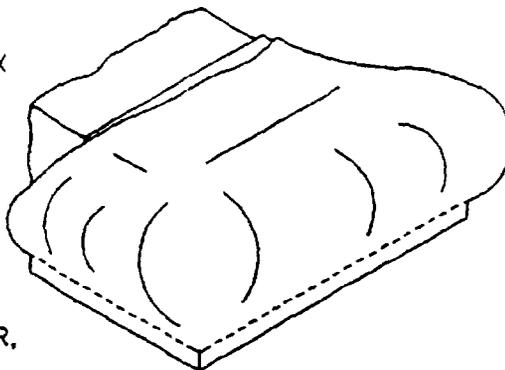
MIL-STD-1389D

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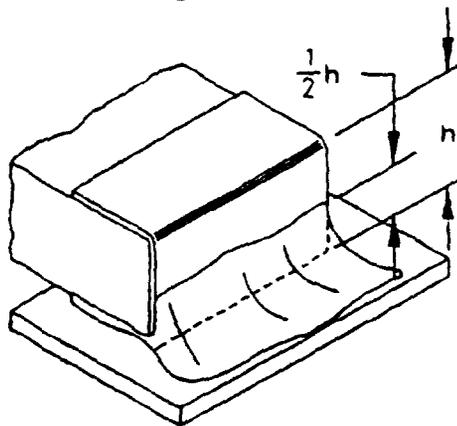
VIEW A
SOLDER HEIGHT MINIMUM
GOOD WETTING EXHIBITED, REGARDLESS
OF ΔCTE



VIEW B
SOLDER HEIGHT MAXIMUM
FILLET EXTENDS TO THE ENTIRE HEIGHT OF
COMPONENT TERMINATION FILLET IS CONVEX
(BULBOUS) AND CAN EXTEND BEYOND ANY
LAND EDGE, PROVIDED THAT POSITIVE ANGLE
IS MAINTAINED MINIMUM SPACING REQUIRE-
MENTS SHALL NOT BE VIOLATED BULBOUS
SOLDER FILLETS WHICH EXTEND BEYOND A
LAND EDGE MUST COMPLETELY CONTACT
THE SOLDERABLE PORTION OF THE LAND,
OUT TO THAT LAND EDGE THE OUTLINE OF
THE END CAP MAY BE OBSCURED BY SOLDER,
SO LONG AS GOOD SOLDER WETTING IS
DISCERNIBLE



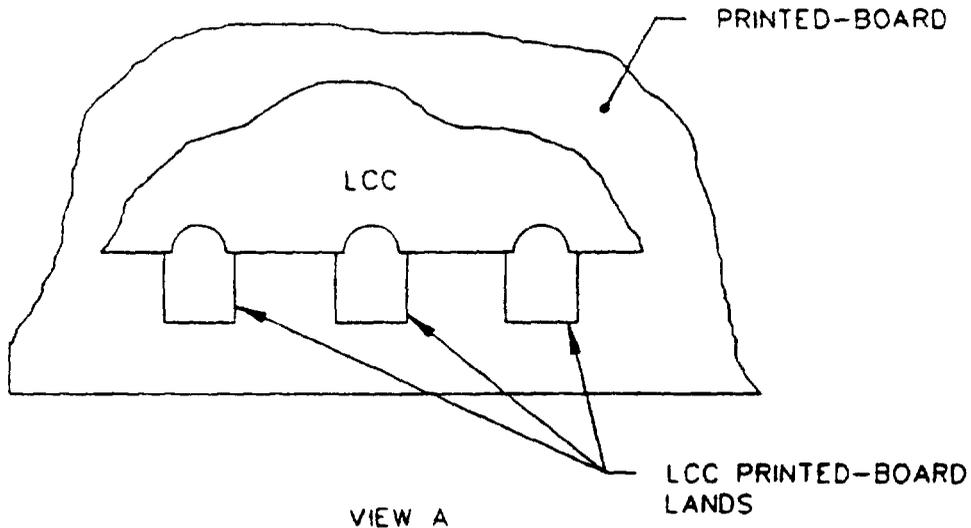
VIEW C
LARGE ΔCTE
FILLET IS CONCAVE AND EXTENDS UP
THE ENTIRE HEIGHT OF COMPONENT
TERMINATION



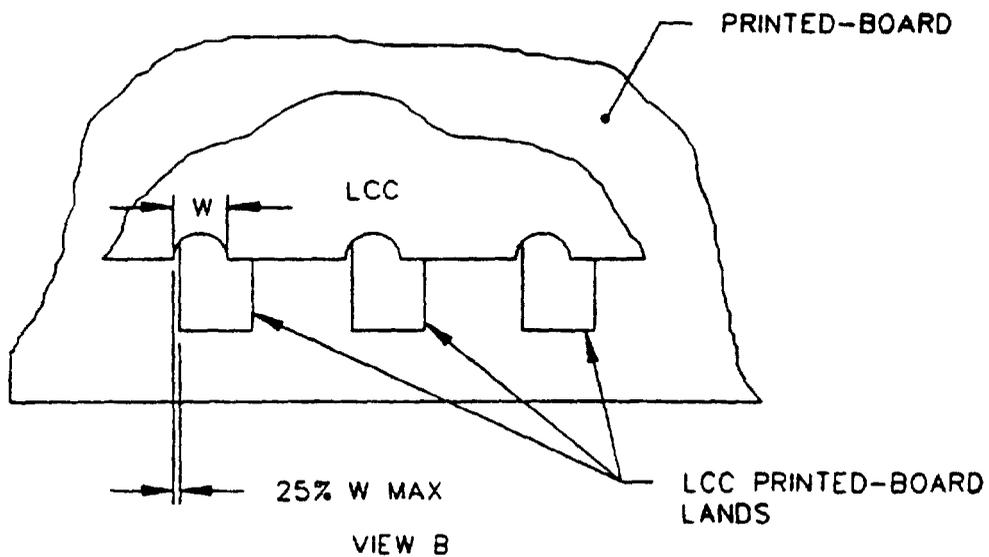
VIEW D
LARGE FIXED TANTALLUM CAPACITORS,
REGARDLESS OF ΔCTE (eg CWR06,
CASE SIZE G & H PER MIL-C-55365)
FILLET MAXIMUM HEIGHT IS HALF OF
THE COMPONENT TERMINATION HEIGHT

FIGURE 59. Leadless part solder wetting - Continued.

MIL-STD-1389D
APPENDIX H



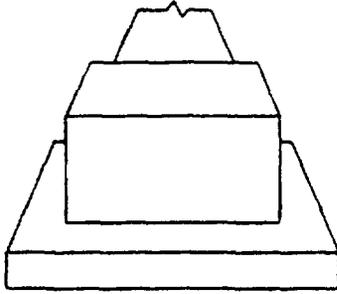
PREFERRED CONFIGURATION DEVICE CASTELLATIONS CENTERED ON MOUNTING LANDS



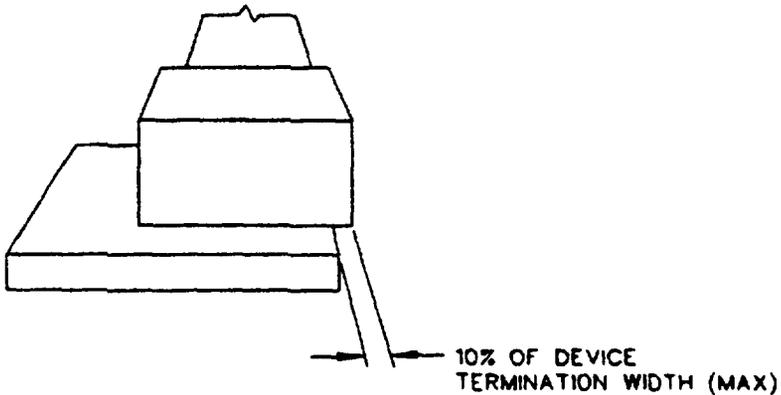
MAXIMUM ALLOWABLE OFFSET OF DEVICE CASTELLATIONS OFF OF MOUNTING LAND, PROVIDED THAT MINIMUM ELECTRICAL SPACING REQUIREMENTS ARE MAINTAINED

FIGURE 60. Leadless part misalignment.

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PREFERRED CONFIGURATION CHIP CAPACITOR OR RESISTOR
END CAP CENTERED TO ALLOW GOOD WETTING ON THE
TERMINATION'S SIDES.



MAXIMUM OVERHANG MAXIMUM ALLOWABLE OVERHANG OF
CHIP CAPACITOR OR RESISTOR OFF MOUNTING LAND,
PROVIDED THAT MINIMUM ELECTRICAL SPACING REQUIREMENTS
ARE MAINTAINED.

FIGURE 61. Chip capacitor misalignment.

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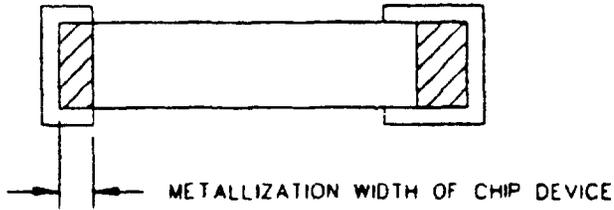


FIGURE 62. Minimum lap of chip on terminal area.

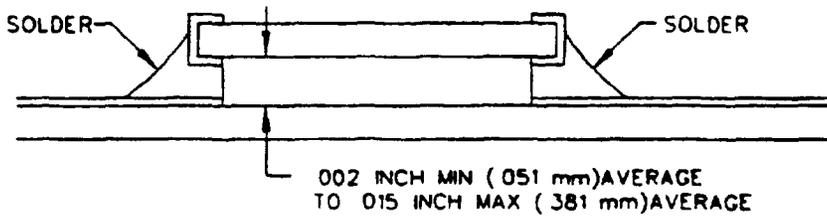
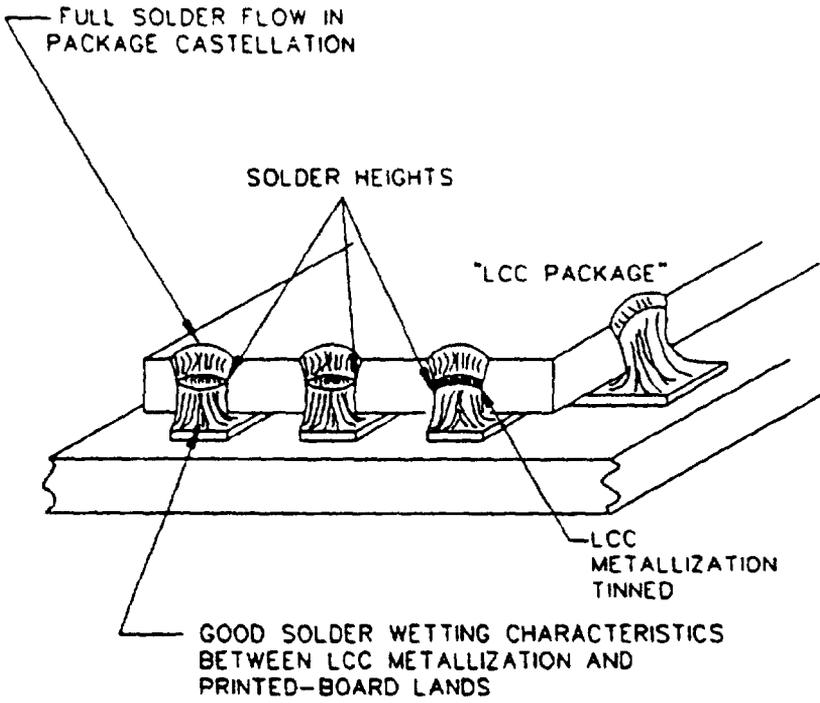


FIGURE 63. Chip elevation for capacitors, resistors, and LCC.

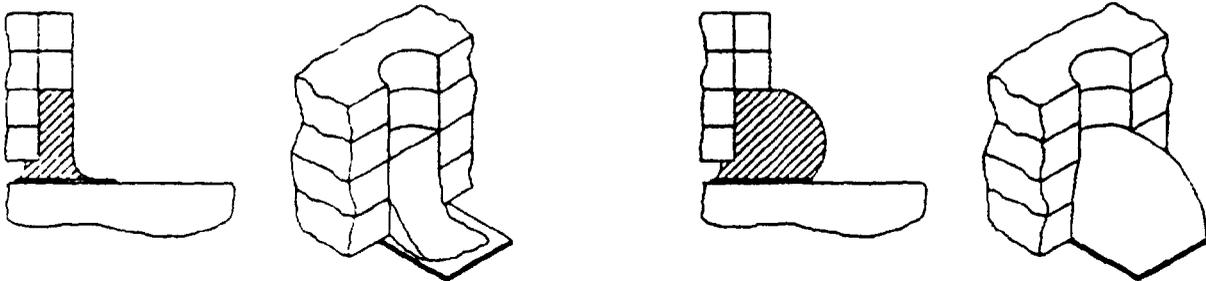
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VIEW A ACCEPTABLE

FIGURE 64. Acceptable LCC solder wetting.

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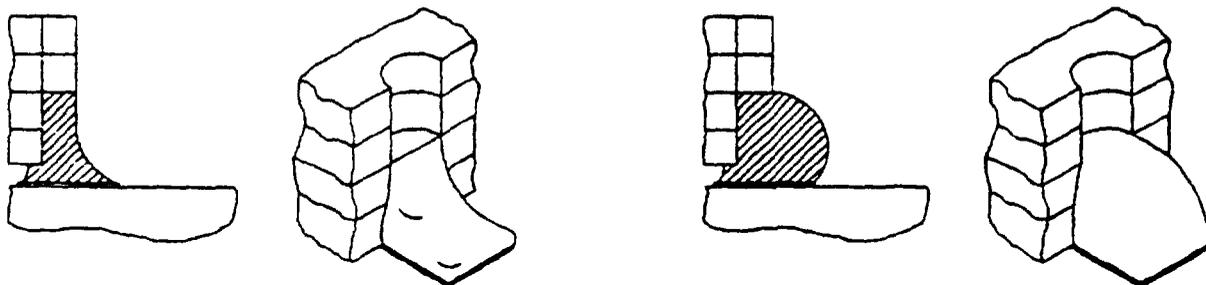


MINIMUM - FILLET OF SOLDER IS THIN BUT EXTENDS UP THE CASTELLATION AND ONTO THE LAND WITH OBSERVABLE WETTING EDGE OF COMPONENT TERMINATION IS NOT DISCERNIBLE

MAXIMUM - FILLET IS CONVEX (BULBOUS) AND CAN EXTEND BEYOND ANY LAND EDGE, SO LONG AS GOOD SOLDER WETTING IS DISCERNIBLE MINIMUM SPACING REQUIREMENTS SHALL NOT BE VIOLATED

VIEW B

SMALL ΔTCE EXISTS BETWEEN COMPONENT AND SUBSTRATE



MINIMUM - FILLET OF SOLDER EXTENDS AT LEAST HALF WAY UP THE CASTELLATION

MAXIMUM - FILLET OF SOLDER IS CONVEX (BULBOUS) AND CAN EXTEND BEYOND ANY LAND EDGE, SO LONG AS GOOD SOLDER WETTING IS DISCERNIBLE. MINIMUM SPACING REQUIREMENTS SHALL NOT BE VIOLATED

VIEW C

LARGE ΔTCE EXISTS BETWEEN COMPONENT AND SUBSTRATE

FIGURE 64. Acceptable LCC solder wetting - Continued.

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APPENDIX H

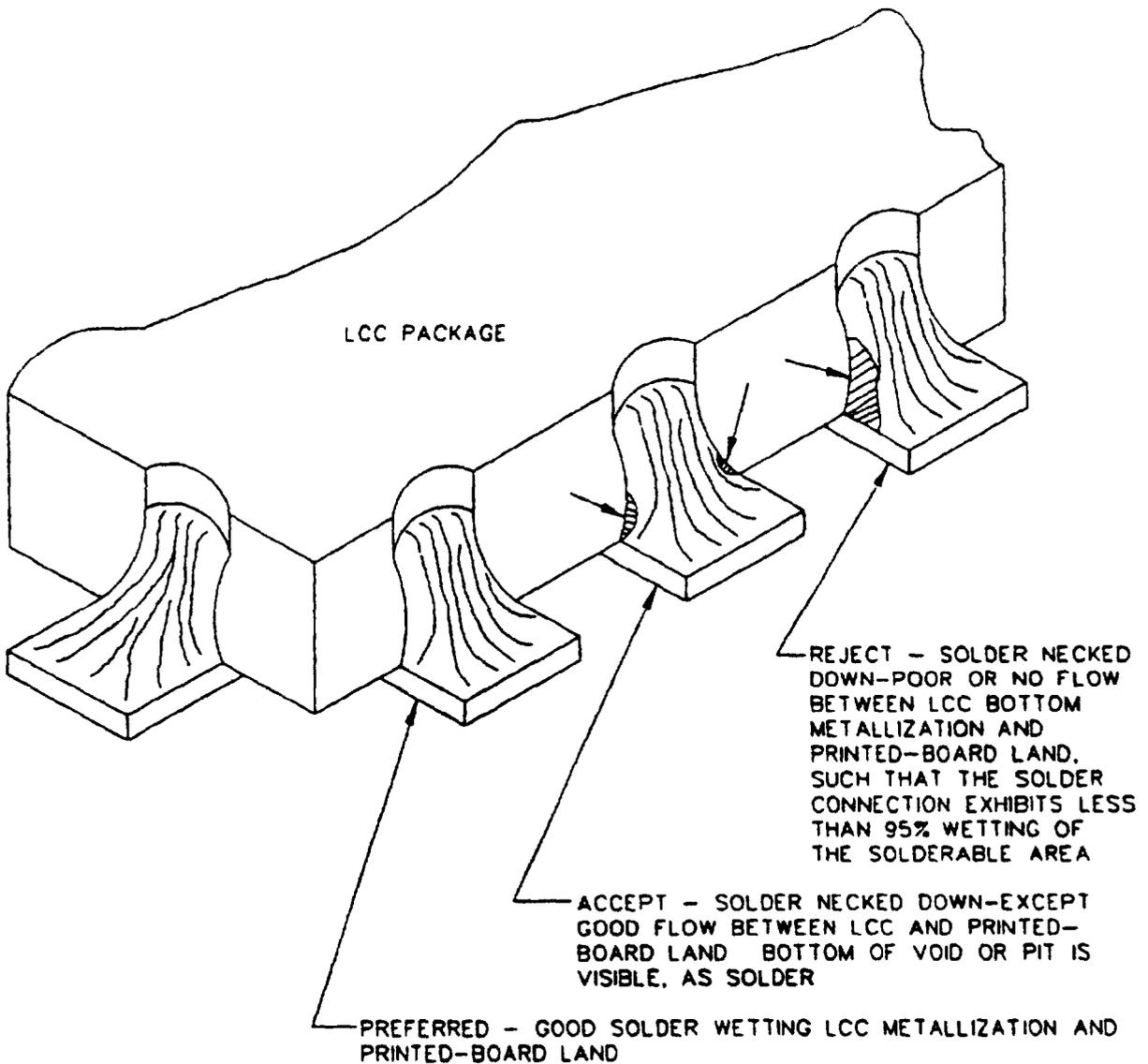
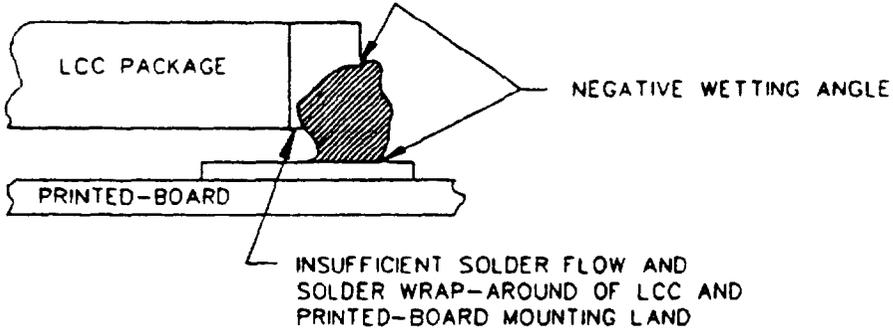


FIGURE 65. LCC solder joint comparison.

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REJECTABLE FILLET FORMATION



ACCEPTABLE FILLET FORMATION

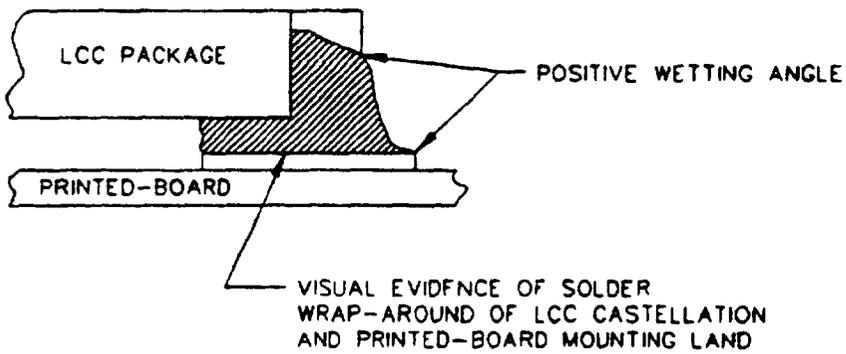
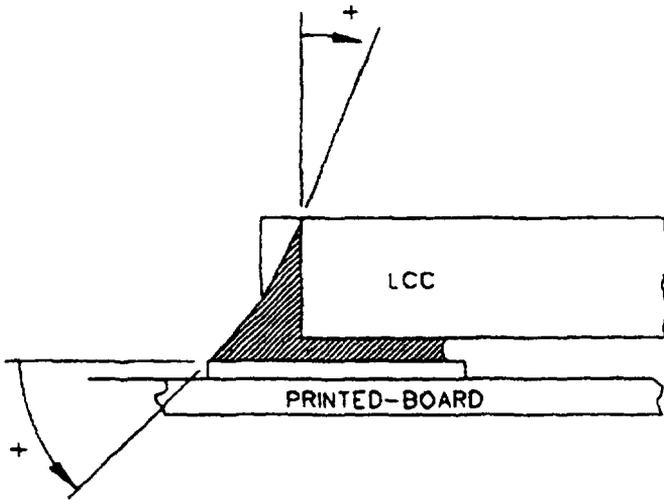


FIGURE 66. LCC fillet formation cross sections.

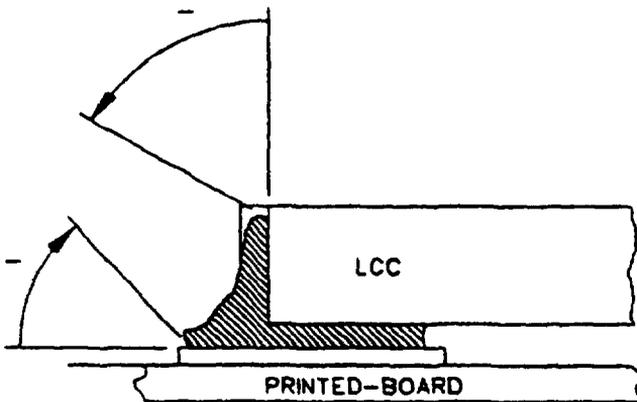
MIL-STD-1389D
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ACCEPT

POSITIVE ANGLE
SOLDER WETTING

SOLDER TAPERS SMOOTHLY
TO THE SURFACE OF THE
CONDUCTOR, MAKING A GOOD
INTERFACIAL CONTACT AT
ALL MATING SURFACES



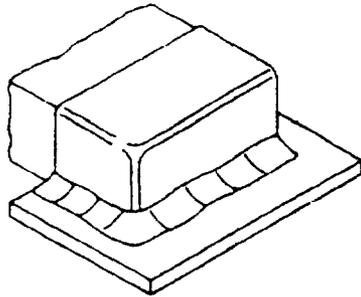
REJECT

NEGATIVE ANGLE
SOLDER WETTING

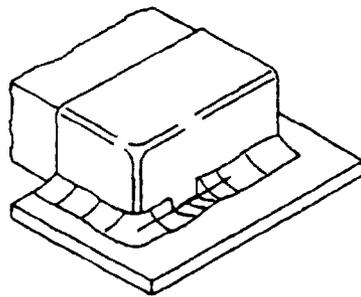
SOLDER DOES NOT TAPER
SMOOTHLY TO TERMINATION
SURFACES

FIGURE 67. LCC solder adherence or flow.

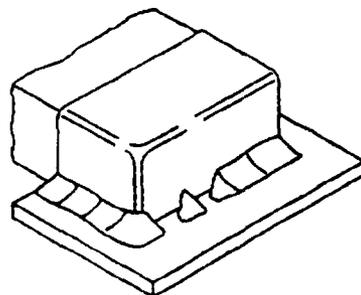
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Preferred - Good solder wetting of chip terminations and substrate land.



Accept - Solder necked down, except good flow between chip terminations and substrate land, bottom of void or pit is visible as solder.

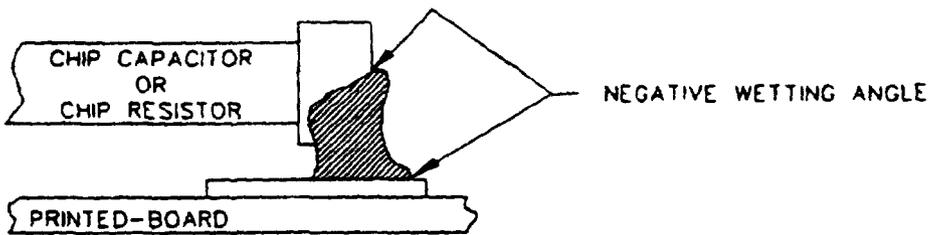


Reject - Solder necked down, poor or no flow between chip bottom metallization and substrate land such that the solder connection exhibits less than 95% wetting of the solderable area.

FIGURE 68. Chip capacitor and resistor solder joint comparison.

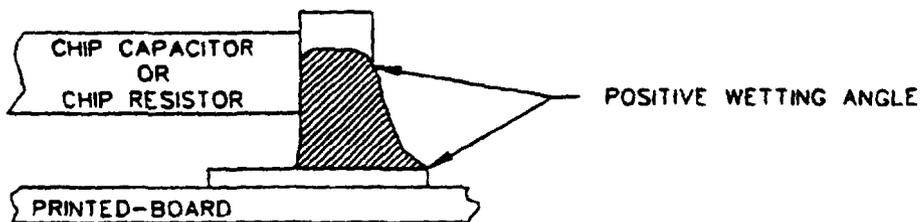
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REJECTABLE FILLET FORMATION



INSUFFICIENT SOLDER FLOW AND
SOLDER WRAP-AROUND OF CHIP TERMINATION
AND PRINTED-BOARD MOUNTING LAND

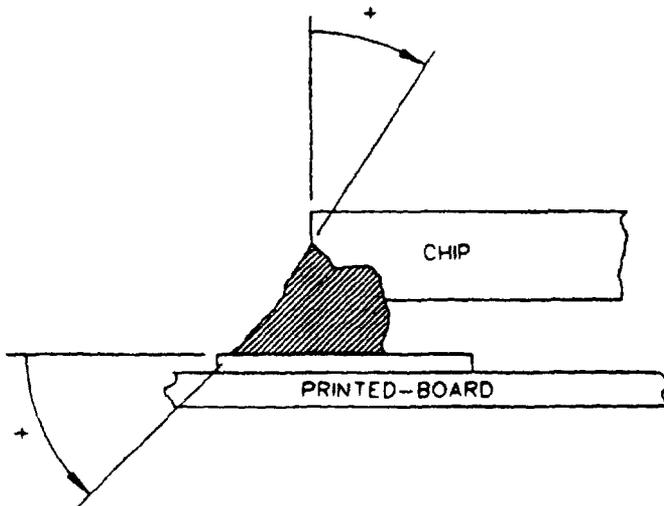
ACCEPTABLE FILLET FORMATION



VISUAL EVIDENCE OF SOLDER
WRAP-AROUND OF CHIP TERMINATION
AND PRINTED-BOARD MOUNTING LAND

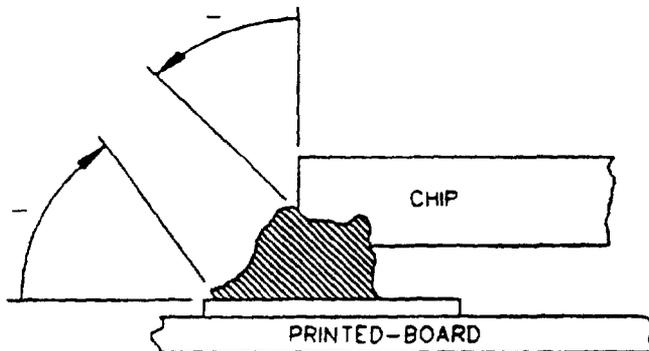
FIGURE 69. Chip capacitor or resistor fillet formation.

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ACCEPT

POSITIVE ANGLE
SOLDER WETTING
SOLDER TAPERS SMOOTHLY
TO THE TERMINATION
SURFACES, MAKING GOOD
INTERFACIAL CONTACT AT
ALL MATING SURFACES



REJECT

NEGATIVE ANGLE
SOLDER WETTING
SOLDER DOES NOT TAPER
SMOOTHLY TO THE TERMINAL
SURFACES

FIGURE 70. Chip capacitor or resistor solder adherence or flow.

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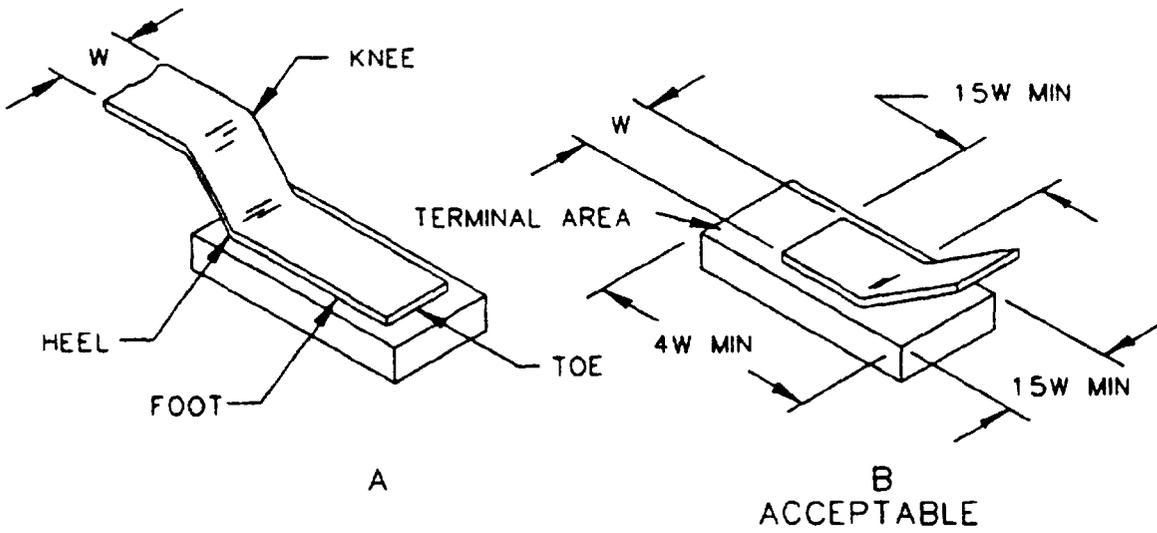


FIGURE 71. Heel mounting requirements for ribbon leads (see 5.1.1.10.3).

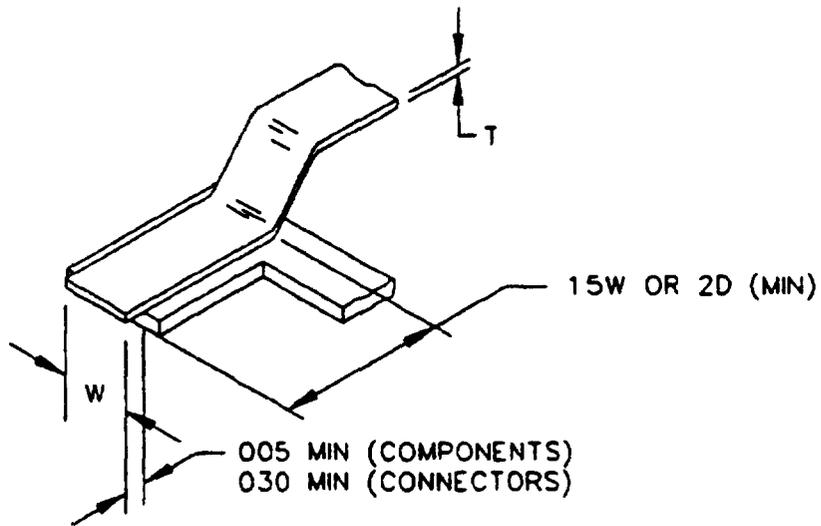


FIGURE 72. Toe overhang limits for ribbon leads (see 5.1.1.10.3 and 5.1.1.10.3.2).

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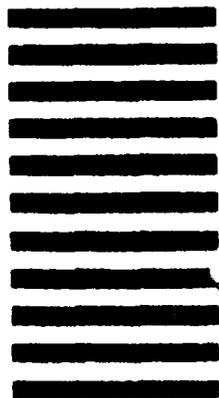
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