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MILITARY STANDARD

DESIGN REQUIREMENTS FOR STANDARD ELECTRONIC MODULES



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DEPARTMENT OF DEFENSE

WASHINGTON, DC 20301

Design Requirements for Standard Electronic Modules

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: Space and Naval Warfare Systems Command (SPAWAR 8111), Department of the Navy, Washington, DC 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWORD

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 module functions for use in the Standard Electronic Modules Program (SEMP).

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 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. Standard Electronic Modules 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.
- Class II - For utilization where more stringent environmental requirements are imposed.
- Class III - For utilization where class I modules may be exposed to radiation.
- Class IV - For utilization where class II modules may be exposed to radiation.

Formats

- Format A - The basic size has a span of 2.62 inches (66.5 mm), a thickness of .290 inches (7.37 mm), and a total height of 1.95 inches (49.5 mm) including keying pins.
- Format B - The basic size has a span of 2.74 inches (69.6 mm), a thickness of .290 inches (7.37 mm), and a total height of 1.95 inches (49.5 mm) including keying pins.
- Format C - The basic size has a span of 5.88 inches (149.4 mm), a thickness of .280 inches (7.11 mm), and a total height of 4.06 inches (103.1 mm) including keying pins.
- Format D - The basic size has a span of 5.88 inches (149.4 mm), a thickness of .280 inches (7.11 mm), and a total height of 4.83 inches (122.7 mm), including keying pins.

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2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense (DODISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

- MIL-E-16400 - Electronic, Interior Communication, and Navigation Equipment, Naval Ship and Shore, General Specification For.
- 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-P-50884 - Printed-Wiring, Flexible and Rigid-Flex.

STANDARDS

MILITARY

- MIL-STD-12 - Abbreviations For Use On Drawings, Specifications, Standards and In Technical Documents.
- DOD-STD-100 - Engineering Drawing Practices.
- MIL-STD-129 - Marking For Shipment and Storage.
- MIL-STD-130 - Identification Marking of US Military Property.
- MIL-STD-242 - Electronic Equipment Parts Selected Standards (Part 1 through 8).
- MIL-STD-275 - Printed Wiring for Electronic Equipment.
- MIL-STD-454 - Standard General Requirements for Electronic Equipment.
- MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
- MIL-STD-883 - Test Methods and Procedures for Microelectronics.
- 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.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DODISS.

- Handbook H4-2 - Federal Supply Code for Manufacturers (United States and Canada) Code to Name.
- Handbook H6 - Federal Item Name Directory.

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

BUMED INSTRUCTION 6270.3 - Personnel Exposure Limits Values for Health Hazardous Air Contaminants.

(Application for copies should be addressed to Naval District Washington, Supply and Fiscal Department (Code 514.3), Washington Navy Yard, Washington, DC 20390).

2.3 Order of precedence. In the event of conflict, the requirements specified in the contract, the detail specification, MIL-M-28787, this standard, and the documents referenced herein shall govern in that order.

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3. DEFINITIONS

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

3.2 SEMP Design Review Activity (SEMP-DRA). The activity responsible for the review and classification of module designs is the Naval Avionics Center, 6000 East 21 Street, Indianapolis, IN 46218 (Code D965).

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

3.4 Key code. An alpha or alpha-numeric (e.g., A4A) designator used to identify the style and angular position of the keying pins.

3.5 Alpha end. The end of a module nearest the lowest numbered pin.

3.6 Beta end. The end of a module farthest from the lowest numbered pin.

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

3.8 Transient critical component temperature (TCCT). The maximum temperature allowed for any component in the module while the module is operated at maximum class temperature plus 20°C without exceeding any individual component TCCT.

3.9 Powered socket. A socket whose terminals are connected to active power supplies, control circuits, loads, and signal sources to simulate system requirements.

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4. GENERAL REQUIREMENTS

4.1 Specification and standards. All 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 SEMP-QAA prior to their use in the design of a module.

4.2 Electrical configuration requirements. Electrical function and pin assignments shall be in accordance with tables I and II. The maximum allowable current for each contact pin shall be 3 amperes (direct current or alternating current root mean square). 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 pin assignments on the new module are identical to those of the existing module.

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

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

- a. Functions shall appear on dedicated pins before they appear on optional or unassigned pins.
- b. Functions shall appear on optional pins before they appear on unassigned pins.
- c. Fixed voltages of different potentials shall not be assigned to adjacent pins.
- d. Any unused pins shall be isolated (not connected to any other used or unused pins).
- e. Pins assigned as dedicated or optional pins may be considered as unassigned only after all the following conditions exist:
 - (1) The pin is not required for the preassigned function.
 - (2) There is a lack of pin availability.
 - (3) All other pin assignment requirements are met.
- f. Optional pin locations shall be used for nonassigned functions before dedicated pins 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 pins shall not be connected together internal to the module. Power ground shall be used if only one type of ground is required.

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4.2.3 Connector pin assignments. The use of connector pin 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. Pins are to be numbered consecutively.
- c. For a 150 pin input/output connector use rows A, B, and E of table II. Pins are to be numbered consecutively.
- d. For a 200 pin input/output connector use rows A, B, D, and E of table II. Pins are to be numbered consecutively.
- e. For a 250 pin input/output connector use rows A through E of table II.

4.3 Environmental requirements. The following environmental requirements apply.

4.3.1 Operating environmental requirements. Modules shall withstand without damage, the operating environmental requirements of MIL-M-28787.

4.3.2 Nonoperating environmental requirements. Modules shall withstand, without damage, the nonoperating environmental requirements of MIL-M-28787.

4.3.2.1 Hydrogen atmosphere. Modules using metal oxide thick film resistors shall be capable of passing the hydrogen atmosphere test specified in MIL-M-28787.

TABLE I. Pin function (40 pins)(40 pin input/output connector pin assignments).

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

* Means optional.

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TABLE II. Pin function (50-250 pins)(50-250 pin input/output connector pin 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. +V*	52. +V*	102.	152.	202.
3. GND*	53. GND*	103.	153. +V*	203. +V*
4. GND*	54. GND*	104.	154.	204.
5. GND*	55. GND*	105.	155. GND*	205. GND*
6. GND*	56. GND*	106.	156.	206.
7. GND*	57. GND*	107.	157.	207.
8. GND*	58. GND*	108.	158.	208.
9. GND*	59. GND*	109.	159.	209.
10. GND	60. GND*	110.	160. GND*	210. GND
11. Frame GND*	61. GND*	111.	161.	211.
12. Analog GND	62. Analog GND*	112.	162.	212.
13. Analog GND	63. Analog GND*	113.	163.	213.
14. Analog GND	64. Analog GND*	114.	164.	214.
15. Analog GND	65. Analog GND*	115.	165. Analog GND*	215. Analog GND*
16. Analog GND	66. Analog GND*	116.	166.	216.
17. Analog GND	67. Analog GND*	117.	167.	217.
18. +5 V*	68. +5 V*	118.	168. +5 V*	218. +5 V*
19. -V dc(1)*	69. -V dc(1)*	119.	169.	219.
20. -V dc(1)*	70. -V dc(1)*	120.	170. -V dc(1)*	220. -V dc(1)*
21. -V dc(1)*	71. -V dc(1)*	121.	171.	221.
22. -V dc(1)*	72. -V dc(1)*	122.	172.	222.
23. -V dc(1)*	73. -V dc(1)*	123.	173.	223.
24. -V dc(1)*	74. -V dc(1)*	124.	174.	224.
25. CONN GND (Not applicable for molded connectors)	75. GND*	125.	175. GND*	225. GND
26. CONN GND (Not applicable for molded connectors)	76. GND*	126.	176.	226.
27. CONN GND (Not applicable for molded connectors)	77. GND*	127.	177.	227.
28. CONN GND (Not applicable for molded connectors)	78. GND*	128.	178.	228.
29. CONN GND (Not applicable for molded connectors)	79. GND*	129.	179.	229.
30. +5 V*	80. +5 V*	130.	180.	230.
31. +5 V*	81. +5 V*	131.	181. +5 V*	231. +5 V*
32. +V	82. +V*	132.	182.	232.
33. +V	83. +V*	133.	183. +V*	233. +V
34. +V	84. +V*	134.	184.	234.
35. GND	85. GND*	135.	185. GND*	235. GND
36. GND	86. GND*	136.	186.	236.
37. GND	87. GND*	137.	187.	237.
38. -V dc(2)	88. -V dc(2)*	138.	188. -V dc(2)*	238. -V dc(2)
39. -V dc(2)	89. -V dc(2)*	139.	189.	239.
40. GND	90. GND*	140.	190. GND*	240. GND
41. GND	91. GND*	141.	191.	241.
42. GND	92. GND*	142.	192.	242.
43. GND	93. GND*	143.	193.	243.
44. GND	94. GND*	144.	194.	244.
45. GND*	95. GND*	145.	195. GND*	245. GND*
46. GND*	96. GND*	146.	196.	246.
47. GND*	97. GND*	147.	197.	247.
48. GND*	98. GND*	148.	198.	248.
49. GND*	99. GND*	149.	199.	249.
50. +5 V*	100. +5 V*	150.	200. +5 V*	250. +5 V*

* Means optional

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5. DETAILED REQUIREMENTS

5.1 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 required module design limits.

5.1.1 Mechanical configuration requirements. The mechanical configurations of modules are specified in appendices A through D. Drawing practices shall be in accordance with the requirements of DOD-STD-100.

5.1.1.1 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, contact pins, and pin shields. On multiple increment modules, the body of the module is permitted to extend below the interface plane within the limits specified in appendices A through D when specified in the detail specification.

5.1.1.2 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 D.

5.1.1.2.1 Rib strength. Individual module ribs shall be capable of withstanding a torque of 10 inch-pounds (1.13 newton-meters) minimum maintained for 10 to 15 seconds. There shall be no detrimental effect to the mechanical integrity of the module.

5.1.1.3 Pin shields. Modules shall be provided with pin shields to protect the contact pins. Details of the pin shields are specified in appendices A through D. Modules are required to have pin shields adjacent to each outside row of module pins. 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.

5.1.1.3.1 Pin shield retention. The pin shield shall withstand a force of 4 pounds (18 newtons) minimum maintained for 10 to 15 seconds without separation from the module or damage to the pin shield. This requirement shall be met after exposure to all manufacturing process temperatures including preconditioning.

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

5.1.1.5 Module connector. The module connector shall be as specified in appendices A through D for the applicable format. All connectors shall be in accordance with the requirements specified herein and in MIL-C-28754. Multiple increment modules may increase contact pin row quantities with each row of pins complete.

5.1.1.5.1 Module contact pins. The number of contact pins on the module and their location shall be as specified in the detail specification. The contact configuration is controlled only on that part of the contact pin protruding from the module connector surface (the interface plane).

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5.1.1.5.2 Connector contact integrity. Each contact pin, 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.

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

5.1.1.6.1 Keying pin locations. There are two keying pin locations on each module designated alpha and beta. The alpha and beta keying pin locations are near the lowest and highest numbered connector pins in the first row, respectively, as illustrated on figure 4. Keying pins on a multiple growth module shall be located at the extreme ends of the first module increment having a connector.

5.1.1.6.2 Keying pin orientation. Keying pins shall be orientated to agree with the basic angle specified for the module by the code letters on figures 1, 2 or 3. Figure 4 illustrates the module axis and specifies the tolerance for angular positioning.

5.1.1.6.3 Keying pin styles. Keying pin styles shall be in accordance with figure 5.

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

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

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

5.1.1.6.7 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.

5.1.1.6.8 Keying pin pushout. Each keying pin shall withstand a pushout force of 40 pounds (178 newtons) applied in 2 to 10 seconds and maintained for 10 to 15 seconds. The force shall be applied in the opposite direction as the force in 5.1.1.6.7.

5.1.1.6.9 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.

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

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

5.1.2.2 Printed-wiring assemblies. The design of printed-wiring assemblies shall conform to the requirements specified in appendix F. Equivalent materials, processes, requirements, and so forth, shall be utilized only when approved by the SEMP-QAA. These equivalent materials, processes, requirements, and so forth, shall be documented and forwarded to the SEMP-QAA for review and approval.

5.1.2.3 Flexible printed wiring and assemblies. Flexible printed wiring and assemblies shall conform to the requirements of MIL-P-50884, type B. Performance, quality assurance and workmanship shall be in accordance with MIL-P-50884.

TABLE III. Keying pin styles and locations.

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

BETA LOCATION ALPHA	A, J 0°	B, K 45°	C, L 90°	135° D, M	E, N 180°	F, P 225°	G, Q 270°	H, R 315°
	A-A A-J J-A J-J	B-B B-K J-B J-K	C-C C-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-R
	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-R
	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 1. Style 1/2 keying chart (viewing connector as shown on figure 4).

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

FIGURE 2. Style 1/1 keying chart (viewing connector as shown on figure 4).

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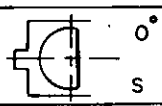
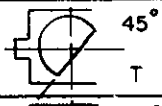
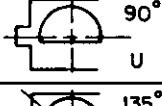
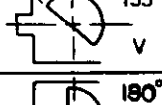
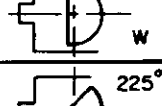
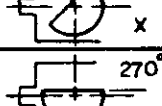
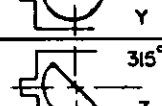

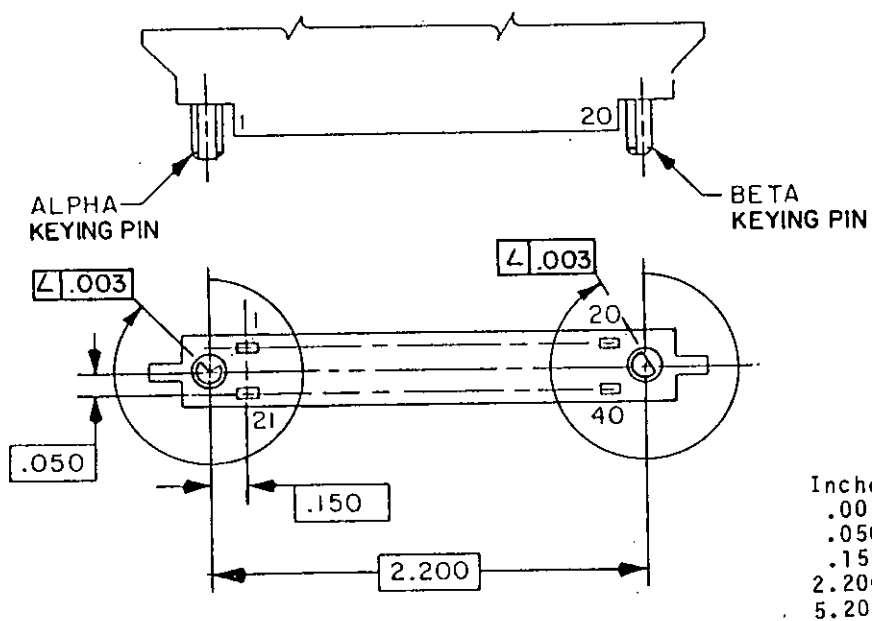
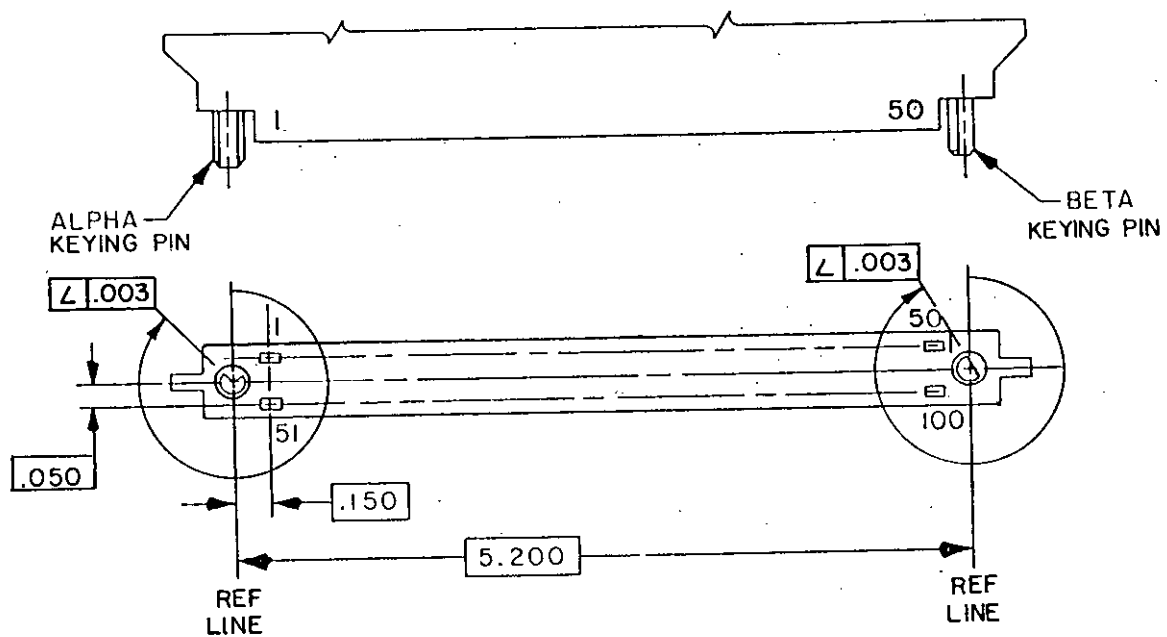
BETA LOCATION ALPHA	S 0°	T 45°	U 90°	V 135°	W 180°	X 225°	Y 270°	Z 315°
	S-S	S-T	S-U	S-V		S-X	S-Y	S-Z
								
						U-X		
						V-X	V-Y	
						W-X	W-Y	W-Z
	X-S					X-X	X-Y	X-Z
	Y-S	Y-T				Y-X	Y-Y	Y-Z
	Z-S	Z-T	Z-U			Z-X	Z-Y	Z-Z

FIGURE 3. Style 2/2 keying chart (viewing connector as shown on figure 4).

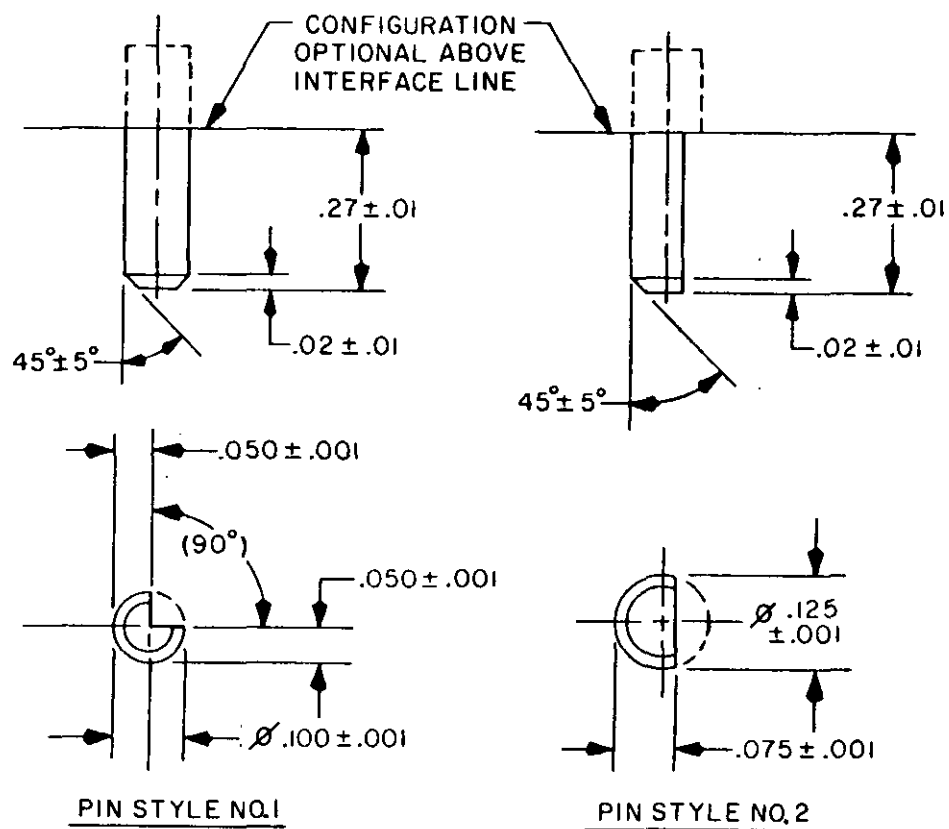
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NOTES:

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

FIGURE 4. Keying pin location.



Inches	mm
.001	0.03
.01	0.3
.02	0.5
.050	1.27
.075	1.90
.100	2.54
.125	3.18
.27	6.9

NOTES:

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

FIGURE 5. Module keying pin styles.

5.1.3 Materials. Materials used in the manufacture of 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.

5.1.3.1 Use of toxic material. Materials which are capable of producing dangerous gasses or other harmful toxic effects as defined in BUMED INSTRUCTION 6270.3 over the temperature range of -55°C to +125°C, or while burning, shall not be used unless suitable nontoxic material is not available.

5.1.3.2 Use of flammable material. Materials used in modules shall be in accordance with the requirements of MIL-STD-454, requirement 3, and shall be self extinguishing within 5 seconds after removal of flame.

5.1.3.3 Use of material affected by fungus. Materials used in modules shall not support fungal growth when tested in accordance with MIL-STD-810, method 508.

5.1.4 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-E-16400 shall be used in the selection of finishes and protective treatments.

5.1.4.1 Anodic treatment/frame plating. Frame surfaces shall be as specified in appendices A through D.

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

5.1.4.3 Conformal coating. The conformal coating shall be in accordance with the requirements of appendix F. 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.

5.1.5 Weight. Modules shall be designed for minimum weight consistent with reliable circuit operation.

5.2 Module marking. All modules shall be identified and marked with appropriate identifiers as specified herein. Appendices A through D specify the marking areas for the following information:

- a. Key code.
- b. Module part number, revision letter and amendment number.
- c. Certification mark.
- d. Module name.
- e. Serial number.
- f. Manufacturer's information.
 - (1) Manufacturer's identification.
 - (2) Date code.
- g. Connector contact identification.
- h. Extractor fin identification.
- i. Electrostatic discharge marking (ESD).

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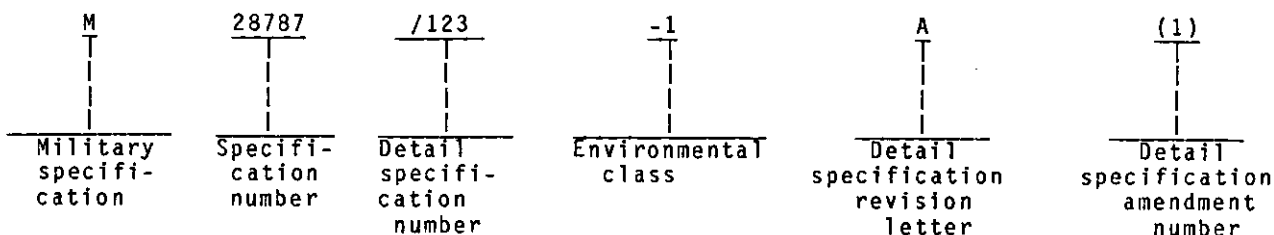
j. RAM/ROM test code.

k. ROM/PROM program code.

All markings excluding key code shall be a minimum of .06 inch (1.5 mm) high and shall be located as specified in appendices A through D and applied in accordance with MIL-STD-130. All marking shall be in a contrasting color to the surrounding module area. All marking shall be permanent and legible in accordance with MIL-STD-1285.

5.2.1 Module key code. The key code assigned to each module shall be marked as specified in appendices A through D. The marking is located at the alpha end of the module on the top surface of the identification fin/header.

5.2.2 Module part number and revision status. The module part number, revision letter, and amendment number shall be marked as specified in appendices A through D. This information is located in the same area as the manufacturer's information. All standard module part numbers will be assigned by the SEMP-DRA. Requests for part number assignment shall be prepared and submitted in accordance with MIL-STD-1378. Modules documented with MIL-STD-961 military specifications shall be marked with the revision status of the specification to which the modules were tested. This marking shall be as follows:



For example, a module could be marked M28787/123-1 A(1). Environmental class I shall be indicated by a -1, environmental class II shall be indicated by a -2, environmental class III shall be indicated by a -3, and environmental class IV shall be indicated by a -4. The detail specification revision letter and amendment number are not a part of the module part number and shall be left blank if none exists. The example part number is not intended to designate a length of field requirement. The length of the part number will vary according to the applicable detail specification.

5.2.2.1 Module part number and revision status for special modules. Part numbers for special modules, as defined in MIL-STD-1378, will be assigned as directed by the acquisition activity. Special modules shall be marked with the revision status of the document to which the modules were built.

5.2.3 Certification mark. All modules that meet the requirements of MIL-M-28787 and the detail specifications shall have the Government certification mark "JAN" or "J" marked as specified in appendices A through D.

5.2.4 Module item name. Each module shall have its item name marked in the area specified in appendices A through D. The item name and manufacturer'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 item name in the title of the detail specification, however, abbreviation in accordance with MIL-STD-12 is permissible. The module design activity is responsible for generation of an approved item name. The item names in H6 shall be used if they appropriately describe the module. When H6 does not list an item name which appropriately describes the module, an item name shall be developed in accordance with MIL-STD-961. The SEMP-DRA is the approval source for item names.

5.2.5 Manufacturer's information. The following information shall be marked with each module at the locations specified in appendices A through D. No other module manufacturer's part number shall be marked on the module.

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5.2.5.1 Manufacturer's identification. Each module shall be marked with either the manufacturer's identification code or manufacturer's name. The manufacturer's code, if utilized, shall be a numerical code as listed in H4-2. A test code assigned by the SEMP-QAA for each vendor's integrated circuit type used shall be marked on each RAM/ROM module in the area specified for a manufacturer's identification.

5.2.5.2 Serial number. Each module shall have a serial number including vendor's designation as specified in appendices A through D. 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.

5.2.5.3 Serial number sequence. Each module manufacturer shall serialize each module manufactured under the requirements of the SEMP. The serial number for any given key code will start with number 1 and continue in numerical sequence as many times as the module is manufactured regardless of contract or customer.

5.2.5.4 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 D. Request for a vendor designation shall be submitted to the SEMP-DRA (see 3.2).

5.2.6 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.

5.2.7 Electrostatic discharge (ESD). Modules that are determined by the SEMP-QAA to require special handling due to sensitivity to electrostatic discharge (ESD) by prior knowledge of device technologies or by testing to MIL-M-28787 shall be marked in the areas specified in appendices A through D with the sensitive electronic device symbol specified in MIL-STD-1285. If the minimum symbol size specified in MIL-STD-129 cannot be met, the size shall be maximized for the particular fin configuration.

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

5.3.1 Personnel safety. Modules with voltages exceeding 30 volts (direct current or alternating current root mean square) to ground shall have exposed conductive frame surfaces (except for pin shields and key pins) connected to either the 0 volt or chassis ground contact pin. The maximum resistance between the ground pin and exposed conductive frame surfaces shall be 1 ohm.

5.3.2 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.

5.3.3 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 parts. Nonhermetically sealed packaged relays and semiconductor devices having hermetically sealed equivalents shall not be used.

5.3.3.1 Germanium semiconductors. Germanium semiconductors shall not be used.

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5.3.3.2 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 SEMP-QQA prior to use.

- a. MIL-S-19500 JANTX devices listed in MIL-STD-242.
- 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.

5.3.3.3 Integrated circuits. Integrated circuits shall be in accordance with the following requirements.

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

- a. The screening shall be to MIL-STD-883, method 5004, class B.
- b. Quality conformance shall be demonstrated in accordance with MIL-STD-883, method 5005, 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.

5.3.3.3.2 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, and d shall be approved by the SEMP-QAA prior to use.

- a. MIL-M-38510 JAN microcircuits listed in MIL-STD-242.
- b. Other MIL-M-38510 JAN microcircuits.
- c. DESC Selected Item Drawing Microcircuits.
- d. Other microcircuit devices shall be equal to or better than MIL-M-38510 JAN devices.

5.3.3.3.3 Restricted usage. Memory devices of identical size and configuration from different suppliers shall not be mixed on individual modules.

5.3.3.3.4 Substitution requirements. A MIL-M-38510 part may be substituted if the quality requirements are met for a vendor approved Specification Control Drawing (SCD) or DESC drawing acquired part. A DESC drawing acquired part may be substituted if the quality requirements are met for the module vendor approved SCD.

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

- a. Established reliability (ER) specification parts (minimum level P if multiple sources exist) listed in MIL-STD-242.
- b. ER parts (minimum level M if required to achieve multiple sourcing) listed in MIL-STD-242.
- c. Other ER parts.
- d. Conventional military specification parts.
- e. ER parts that use the Weibull failure rate prediction method, such as MIL-C-39003, shall require a B minimum failure rate level.

5.3.3.5 Hybrid microcircuits. Hybrid microcircuits shall be in accordance with the requirements of MIL-STD-883 and MIL-M-38510, or equivalent.

- a. Hybrid microcircuits which are contained in packages having an inner seal perimeter of 2.0 inches (51 mm) or greater shall be in accordance with the requirements of MIL-STD-883, method 5008.
- b. Hybrid microcircuits which are contained in packages having a seal perimeter of less than 2.0 inches (51 mm) shall be in accordance with the requirements of MIL-STD-883, method 5004 and 5005, class B, or method 5008.

All equivalent specifications shall be submitted to the SEMP-QAA for approval prior to initial qualification.

5.3.4 Life expectancy. Modules shall be designed for a minimum life expectancy of 100,000 hours operation at maximum temperature for the appropriate class.

5.3.5 Failure rate. The failure rate production specified in MIL-M-28787 shall be calculated in accordance with appendix E.

6. NOTES

6.1 Subject term (keyword) listing.

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

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

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APPENDIX A

DESIGN REQUIREMENTS FOR FORMAT A MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the design requirements for format A modules to be used in the Standard Electronic Modules Program (SEMP).

20. REFERENCED DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified herein.

SPECIFICATION

MILITARY

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

STANDARD

FEDERAL

FED-STD-595 - Colors.

(Copies of the specification and standard required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

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 6 and 7 and in table IV.

30.2 Thermal requirements. All 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 (66.5 mm), a thickness of .290 inches (7.37 mm), and is 1.95 inches (49.5 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 inch (76.20 mm) increments and thickness shall be increased in .300 inch (7.62 mm) increments as shown in table IV. All module configurations and size designation shall conform to the span and thickness matrix of table IV. Dimensions and tolerances shall be as specified on figures 7 and 8. Plate mounted modules shall be in accordance with figure 9 and sub-plate mounted modules shall be in accordance with figure 10.

40.1.1 Circuitry. External circuitry and components shall be contained within an area defined by the following: A minimum of .050 inch (1.27 mm) inward on each side from two vertical parallel lines established by the CC dimension and a maximum of 1.286 inches (32.66 mm) measured vertically from the interface plane (see figure 7).

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APPENDIX A

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 or both.

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. The fin cross section and spacing shall be in accordance with figure 12.

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 in accordance with 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 in view A of figure 12. All module extractor fins shall have extractor holes in accordance with figures 7 and 8. When the insertion and extraction fin is not the marking fin, it shall be identified as specified on figure 13.

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 be capable of withstanding 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 in a direction perpendicular to the plane of the fin without detrimental effect to the mechanical or electrical properties of the module. During the time the torque is applied, the module shall be rigidly supported within a zone between the interface plane and 0.5 inch (13 mm) above the interface plane.

40.1.2.6 Fin cantilever load. The fin shall be capable of withstanding 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 without detrimental effect to the fin structure.

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 7 and 8.

40.1.4 Module connector. The basic 1A module connector shall have either 20 or 40 metal bayonet type contact pins. Multiple increment modules may have more contact pins with the quantity increasing in increments of 20 contact pins. Unused rows of contact pins need not be present in the connector but any row of 20 pins shall be complete. All connectors shall conform to the requirements specified herein and in MIL-C-28754. Optional connector configuration for double span modules is a 100 pin 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 7. 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 8. 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 11, provides a means for complete identification of any contact pin on the module. All 100 pin connectors shall have the contacts numbered from 1 to 100 as shown on figure 11.

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 11 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. All connectors located within each span are designated with that span number (see figure 11). Span identification is not required for use of 100 pin 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 14. Pin numbers 21 and 40 need not be identified when the contacts are not in the module or when in multiple thickness modules, pins 21 and 40 are located in the A increment. In multiple thickness modules, when pins 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 pin 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 pin location. The location of contact pins for a typical 1A module shall be as shown on figure 7.

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 either direction. The total computed force shall be applied simultaneously to all module connector pins 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 be capable of withstanding 500 cycles of mating and unmating with no degradation of module performance.

40.1.5.3 Inclination. The module shall be capable of continuous operation while being inclined at the rate of 5 to 7 cycles per minute in all vertical planes to an angle of 45 degrees from vertical.

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40.1.5.4 Module retention. On multiple increment modules, the use of slotted holddown screws is permitted. Holes for the module holddown screws shall be located at the .300 inch (7.62 mm) thickness increment centerline and the 2.200 inch (55.88 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 screws which will permit a minimum of .015 inch (0.38 mm) radial float. The captive screws shall extend .200 to .270 inch (5.08 to 6.86 mm) beyond the interface plane with the .112 inch (2.84 mm) diameter extension below the interface plane being fully threaded. Captive means shall ensure the screw does not interfere with the insertion and extraction of the module. Holddown screws shall not be located in the first module connector increment. Holddown screws 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 grams).
- c. Module exceeds 12 increments in thickness.

40.1.5.5 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 3).

40.1.5.6 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 critical component temperatures (CCI 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 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.

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40.2.3 Component temperatures. The following requirements for critical component temperature (CCT) and transient critical component temperature (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.

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

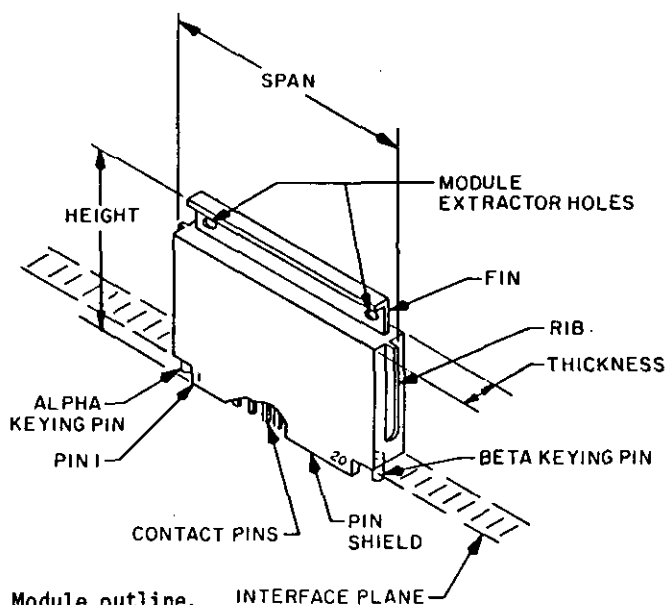


FIGURE 6. Module outline.

TABLE IV. Module span and thickness increments. 3/ 4/

Span 1/ 3.00 inch (76.2 mm) increments		Thickness 2/									
Span design	DIM INCH	A .290 (7.37)	B .590 (14.99)	C .890 (22.61)	D 1.190 (30.23)	E 1.490 (37.85)	F 1.790 (45.47)	G 2.090 (53.09)	H 2.390 (60.71)	J 2.690 (68.33)	K 2.990 (75.95)
1	2.62 (66.5)	1A	1B	1C	1D	1E	1F	1G	1H	1J	1K
2	5.62 (142.7)	2A	2B	2C	2D	2E	2F	2G	2H	2J	2K
3	8.62 (219.9)	3A	3B	3C	3D	3E	3F	3G	3H	3J	3K

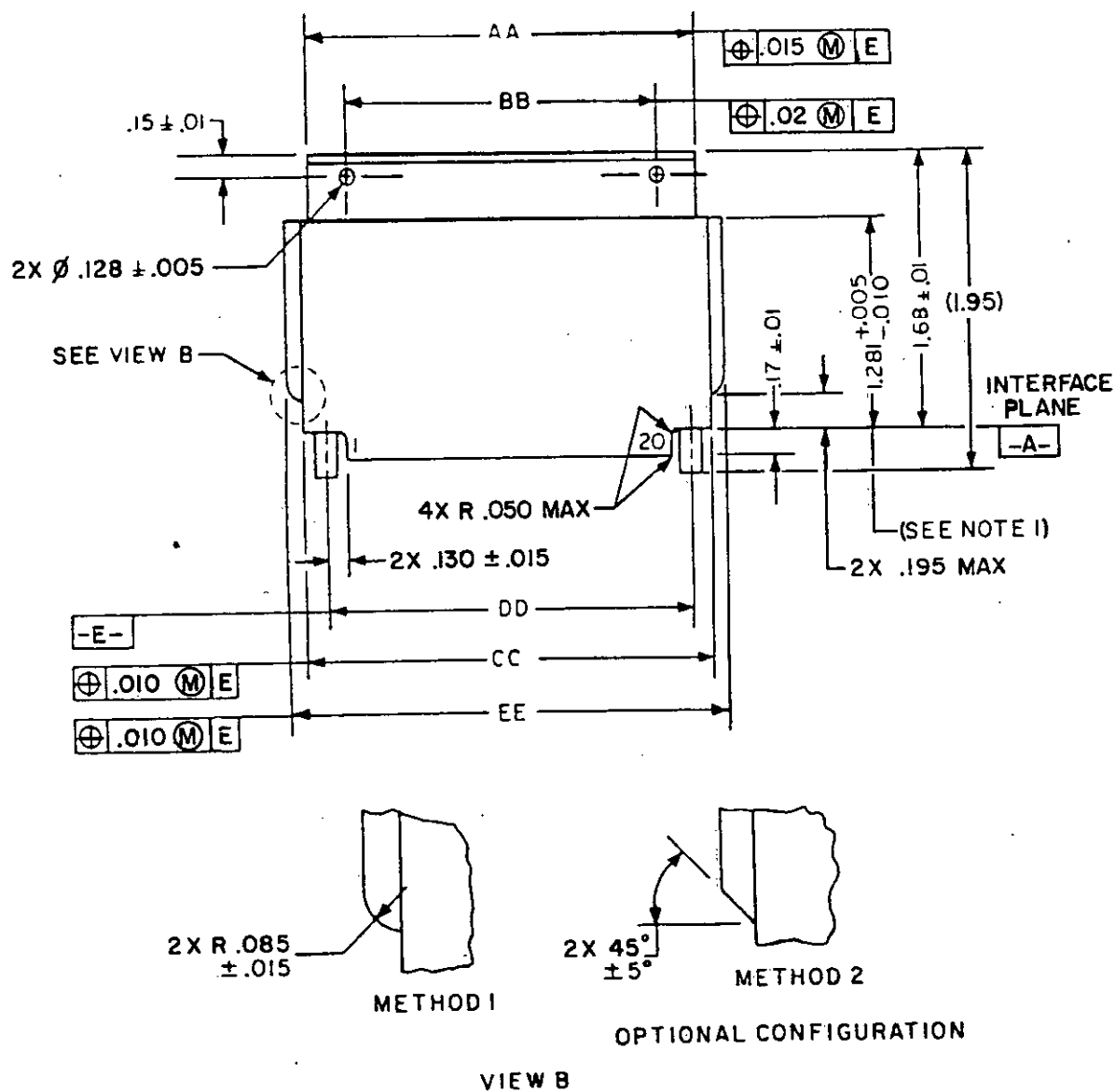
L 3.290 (83.57)	M 3.590 (91.19)	N 3.890 (98.81)	P 4.190 (106.43)	R 4.490 (114.05)	S 4.790 (121.67)	T 5.090 (129.29)	U 5.390 (136.91)	V 5.690 (144.53)	W 5.990 (152.15)	Y 6.290 (159.77)	Z 6.590 (167.3)
1L	1M	1N	1P	1R	1S	1T	1U	1V	1W	1Y	1Z
2L	2M	2N	2P	2R	2S	2T	2U	2V	2W	2Y	2Z
3L	3M	3N	3P	3R	3S	3T	3U	3V	3W	3Y	3Z

1/ Span is measured across the ribs.

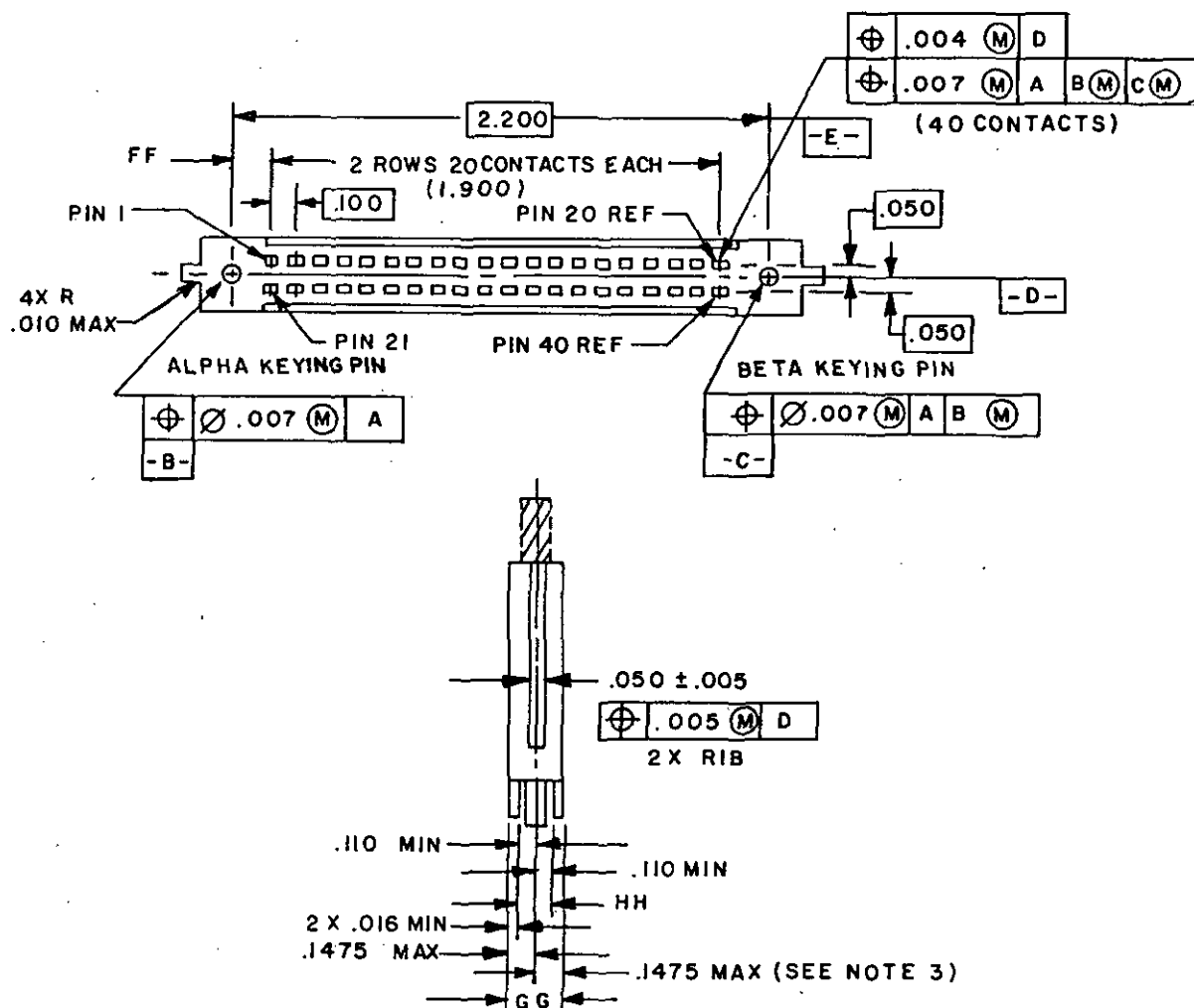
2/ Each letter is .300 inch (7.62 mm) greater than the previous letter with "A" equal to .290 inch (7.37 mm) maximum.

3/ Dimensions are in inches.

4/ Metric equivalents are given for general information only.

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APPENDIX AFIGURE 7. Module basic size outline.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm
.004	0.10	.02	0.5	.1475	3.746	1.95	49.5
.005	0.13	.050	1.27	.15	3.8	2.200	55.88
.007	0.18	.085	2.16	.17	4.3		
.010	0.25	.100	2.54	.195	4.95		
.01	0.3	.110	2.79	1.281	32.54		
.015	0.38	.128	3.25	1.68	42.7		
.016	0.41	.130	3.30	1.900	48.26		

NOTES:

1. The $1.281 + .005, -.010$ inches ($32.54 + 0.13, -0.25$ 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 (32.66 mm) maximum.
2. See table V for letter dimensions.
3. The .1475 inch (3.746 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.

FIGURE 7. Module basic size outline - Continued.

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APPENDIX ATABLE V. Module span and thickness dimensions.
(see figures 7 and 8 for details). 1/ 2/

Span	Dimensions					
	AA ±.01 (0.3)	BB ±.01 (0.3)	CC +.005 (0.13) -.075 (1.90)	DD basic	EE ±.01 (0.3)	FF basic
1	2.32 (58.9)	1.89 (48.0)	2.440 (61.98)	2.200 (55.88)	2.62 (66.5)	.150 (3.81)
2	5.32 (135.1)	4.89 (124.2)	5.440 (138.18)	5.200 (132.08)	5.62 (142.7)	.150 (3.81)
3	8.32 (211.3)	7.89 (200.4)	8.440 (214.38)	8.200 (208.28)	8.62 (218.9)	.150 (3.81)

Thickness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
A	.290 (7.37)	.220 (5.59)	0
B	.590 (14.99)	.520 (13.21)	.300 (7.62)
C	.890 (22.61)	.820 (20.83)	.600 (15.24)
D	1.190 (30.23)	1.120 (28.45)	.900 (22.86)
E	1.490 (37.85)	1.420 (36.07)	1.200 (30.48)
F	1.790 (45.47)	1.720 (43.69)	1.500 (38.10)
G	2.090 (53.09)	2.020 (51.31)	1.800 (45.72)
H	2.390 (60.71)	2.320 (58.93)	2.100 (53.34)
J	2.690 (68.33)	2.620 (66.55)	2.400 (60.96)
K	2.990 (75.95)	2.920 (74.17)	2.700 (68.58)
L	3.290 (83.57)	3.220 (81.79)	3.000 (76.20)

Thickness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
M	3.590 (91.19)	3.520 (89.41)	3.300 (83.82)
N	3.890 (98.81)	3.820 (97.03)	3.600 (91.44)
P	4.190 (106.43)	4.120 (104.65)	3.900 (99.06)
R	4.490 (114.05)	4.420 (112.27)	4.200 (106.68)
S	4.790 (121.67)	4.720 (119.89)	4.500 (114.30)
T	5.090 (129.29)	5.020 (127.51)	4.800 (121.92)
U	5.390 (136.91)	5.320 (135.13)	5.100 (129.54)
V	5.690 (144.53)	5.620 (142.75)	5.400 (137.16)
W	5.990 (152.15)	5.920 (150.37)	5.700 (144.78)
Y	6.290 (159.77)	6.220 (157.99)	6.000 (152.40)
Z	6.590 (167.39)	6.520 (165.61)	6.300 (160.02)

1/ Dimensions are in inches.

2/ Metric equivalents are given for general information only.

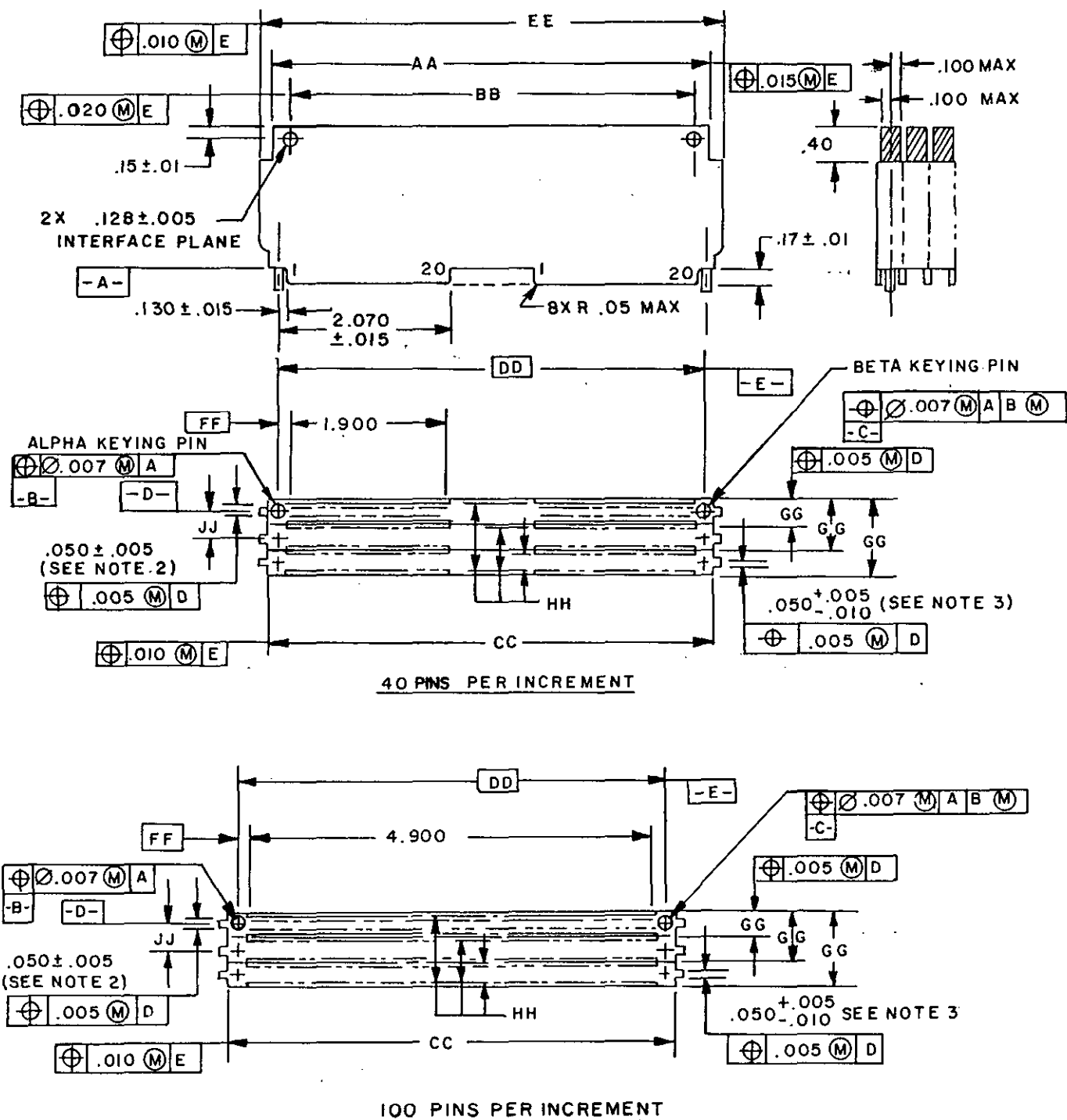
MIL-STD-1389C
APPENDIX A

FIGURE 8. Multiple increment module outline.

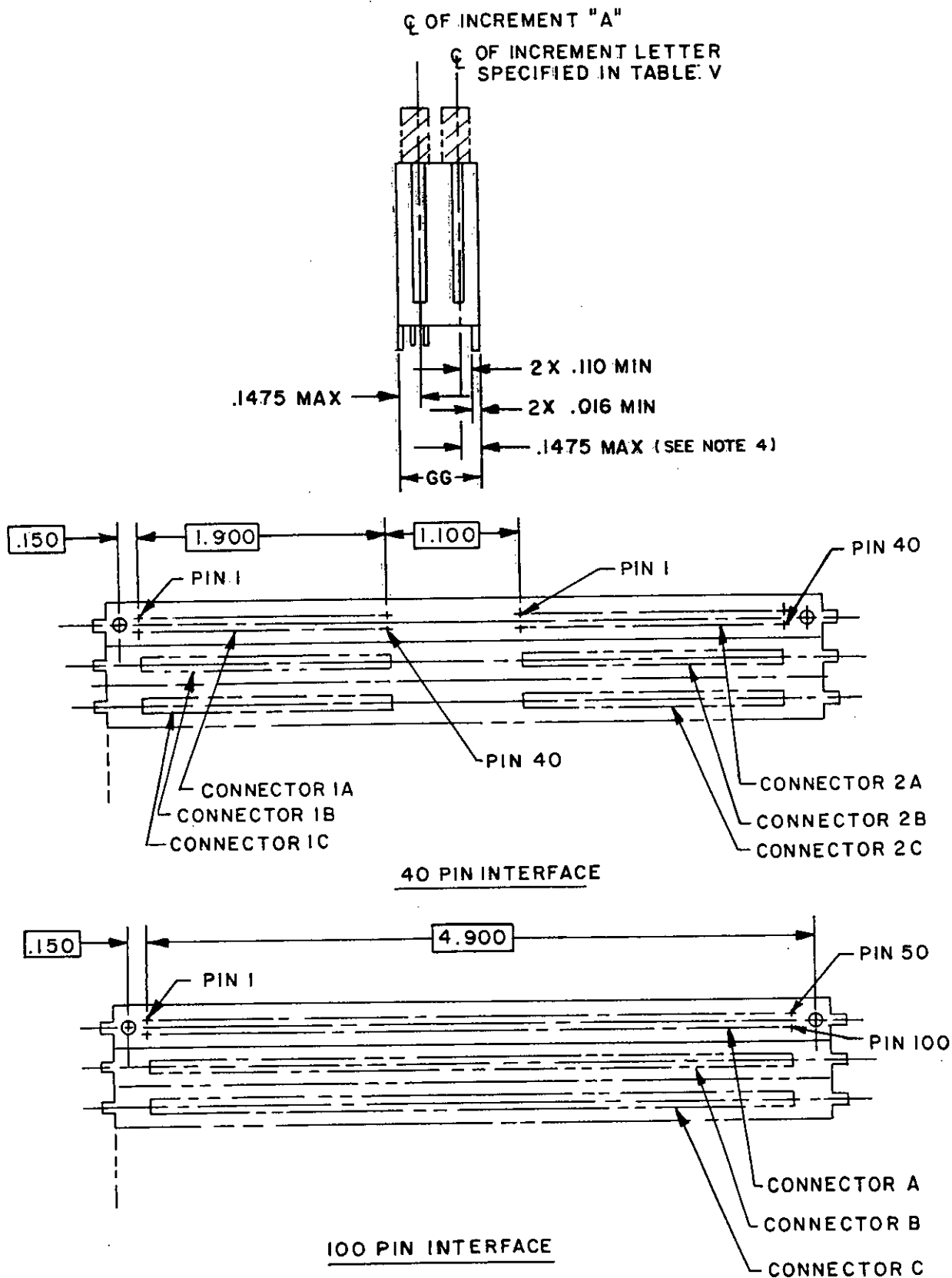
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FIGURE 8. Multiple increment module outline - Continued.

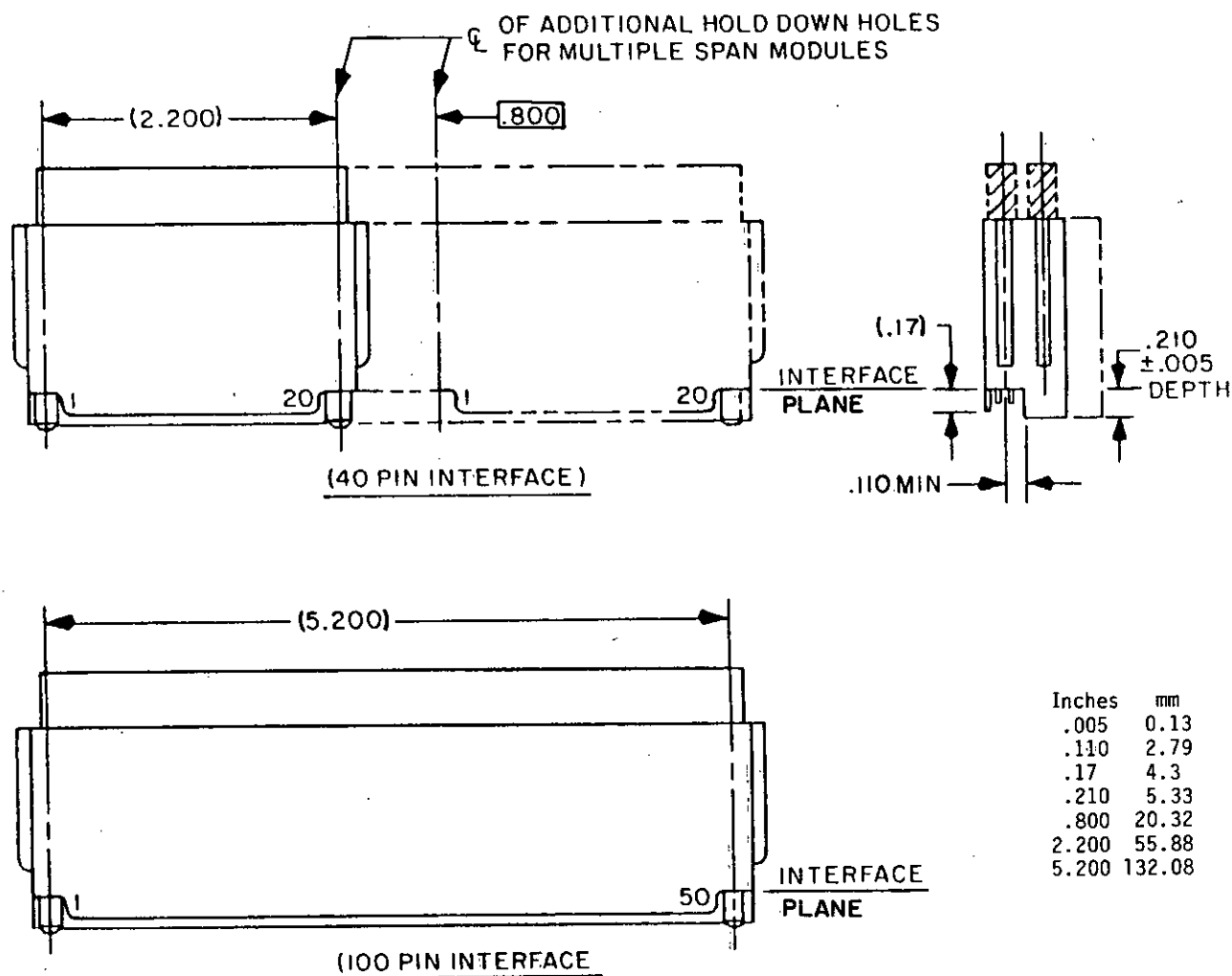
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Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
.005	0.13	.020	0.51	.128	3.25	.17	4.3	4.900	124.46
.007	0.18	.050	1.27	.130	3.30	.40	10.2		
.010	0.25	.05	1.3	.1475	3.746	1.100	27.94		
.01	0.3	.100	2.54	.150	3.81	1.900	48.26		
.015	0.38	.110	2.79	.15	3.8	2.070	52.58		
.016	0.41								

NOTES:

1. Module pin shields are only required for the external protection of contact pins and are not required for module increments which do not contain contact pins.
2. The .050 \pm .005 inch dimension (1.27 \pm 0.13 mm) applies to the first module increment only.
3. The .050 \pm .005, -.010 inch dimension (1.27 \pm 0.13, -0.25 mm) applies to all module increments except the first.
4. The .1475 inch (3.746 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimensions GG maximum governs.
5. See table V 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.

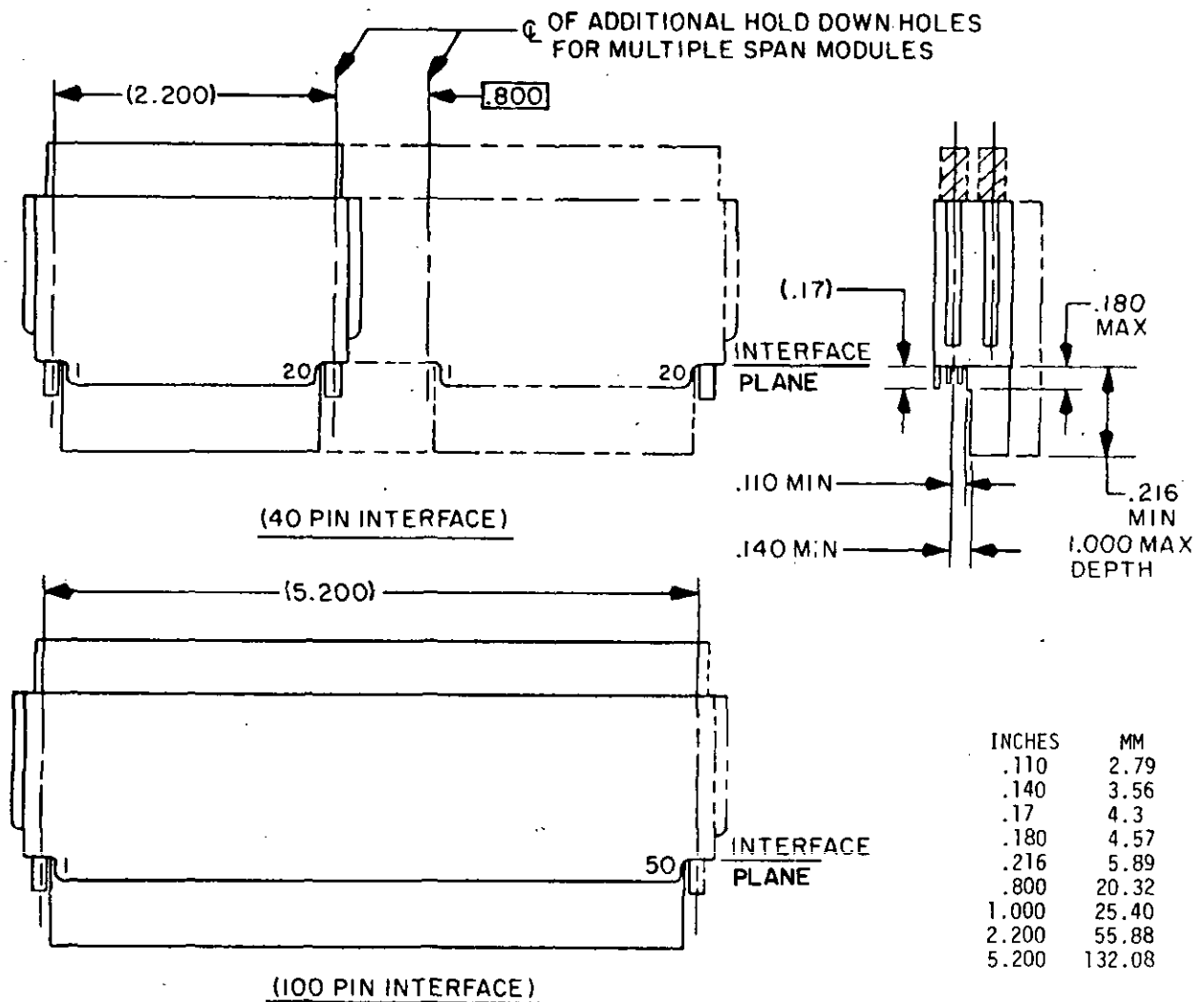
FIGURE 8. Multiple increment module outline - Continued.

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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.

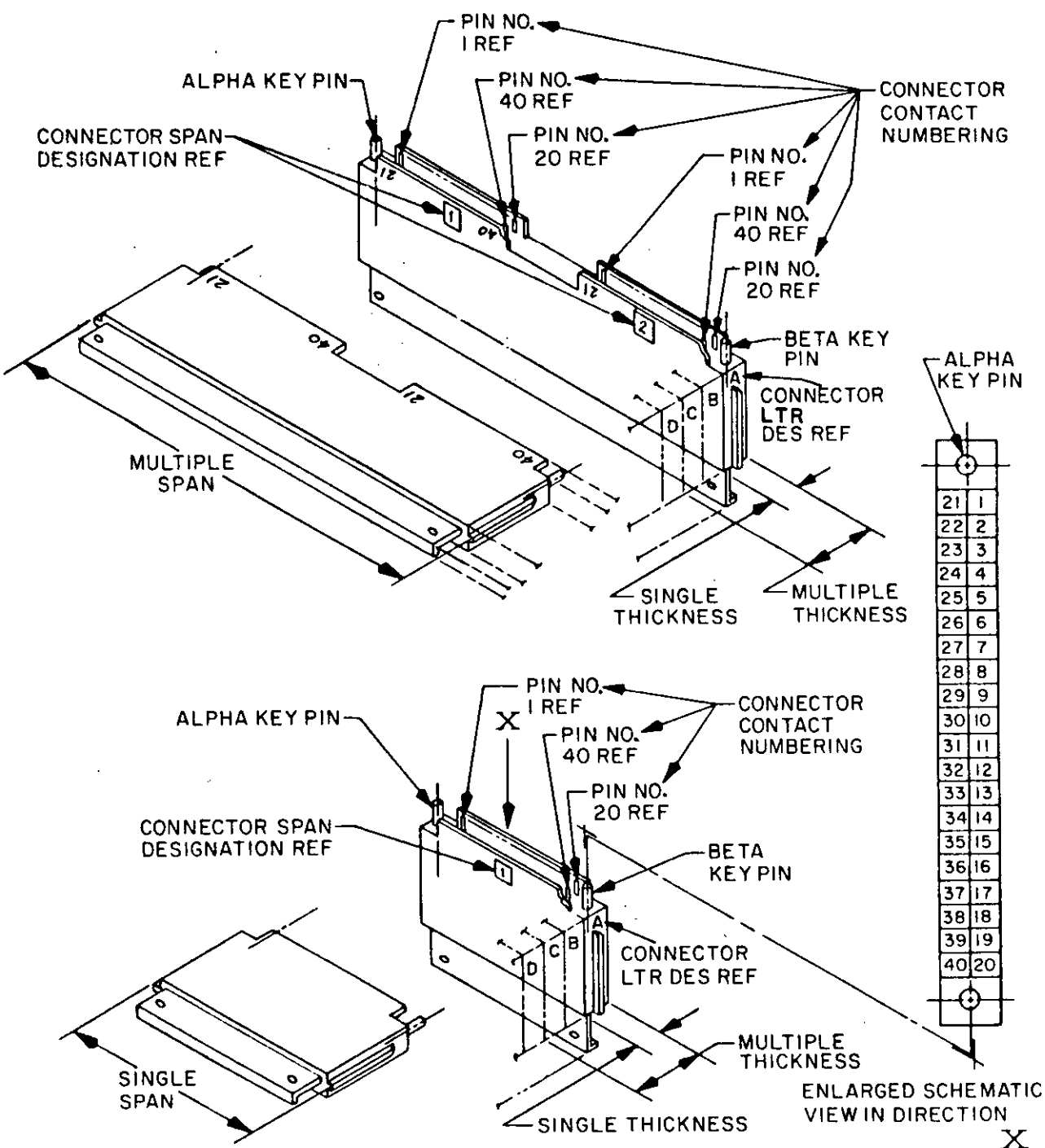
FIGURE 9. Plate mounted module outline.

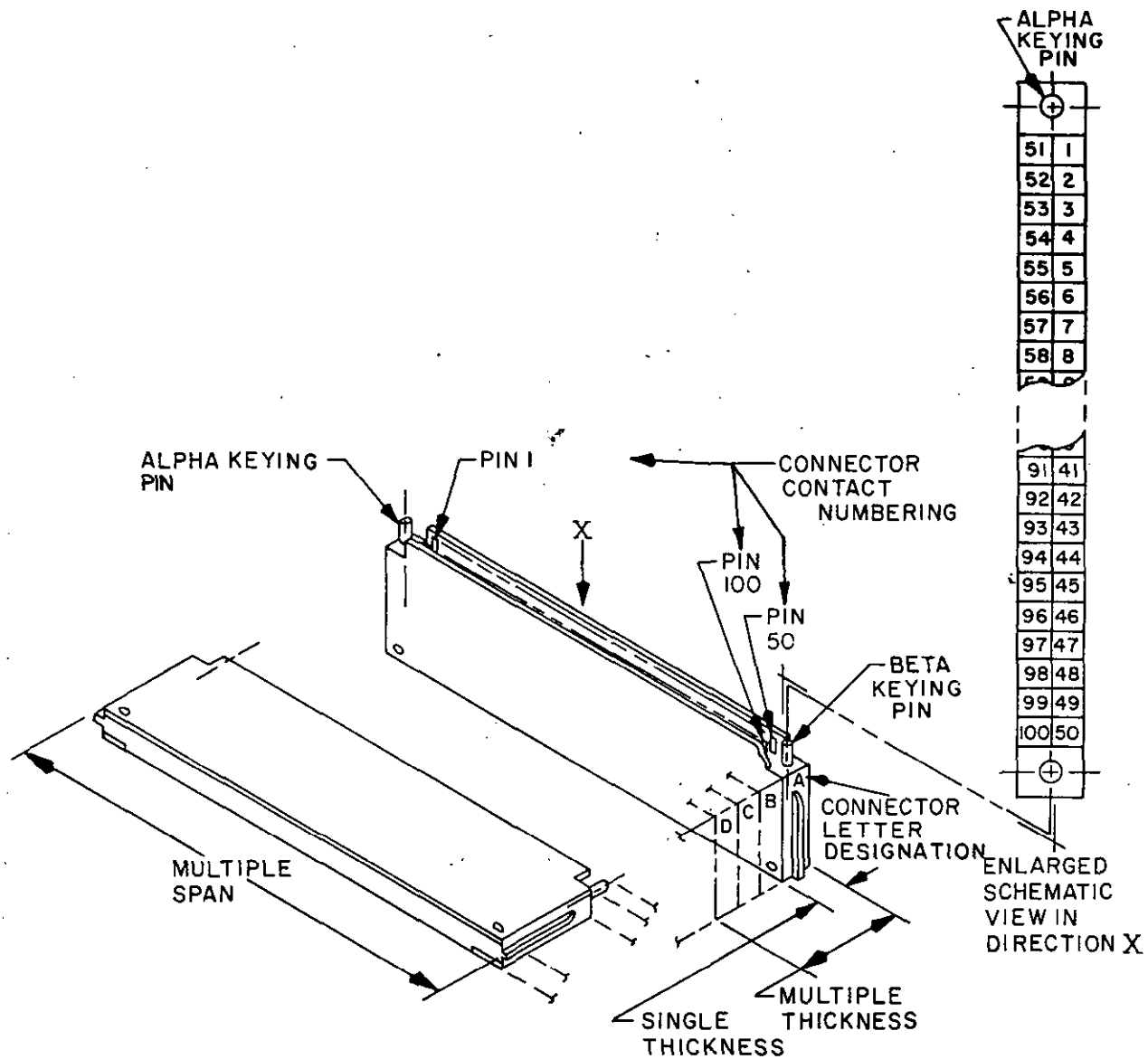
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NOTES:

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 10. Sub-plate mounted module outline.

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APPENDIX AFIGURE 11. Connector contact assignment.

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APPENDIX AFIGURE 11. Connector contact assignment - Continued.

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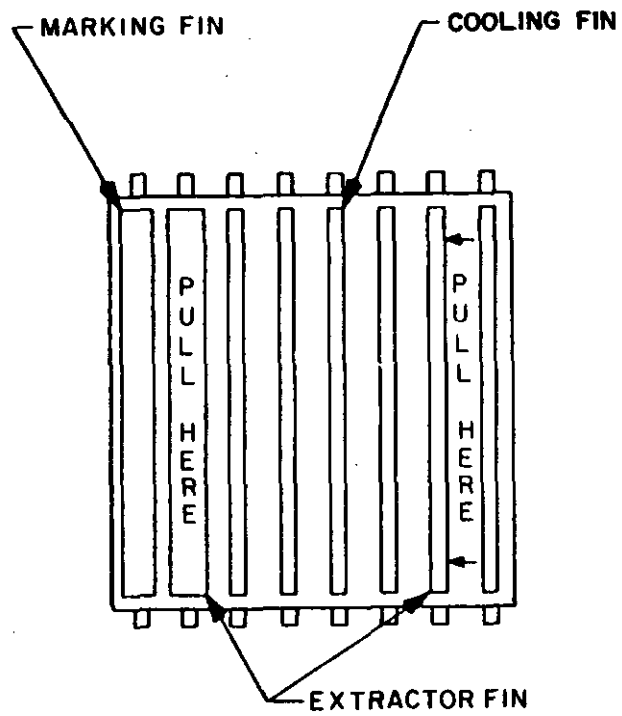
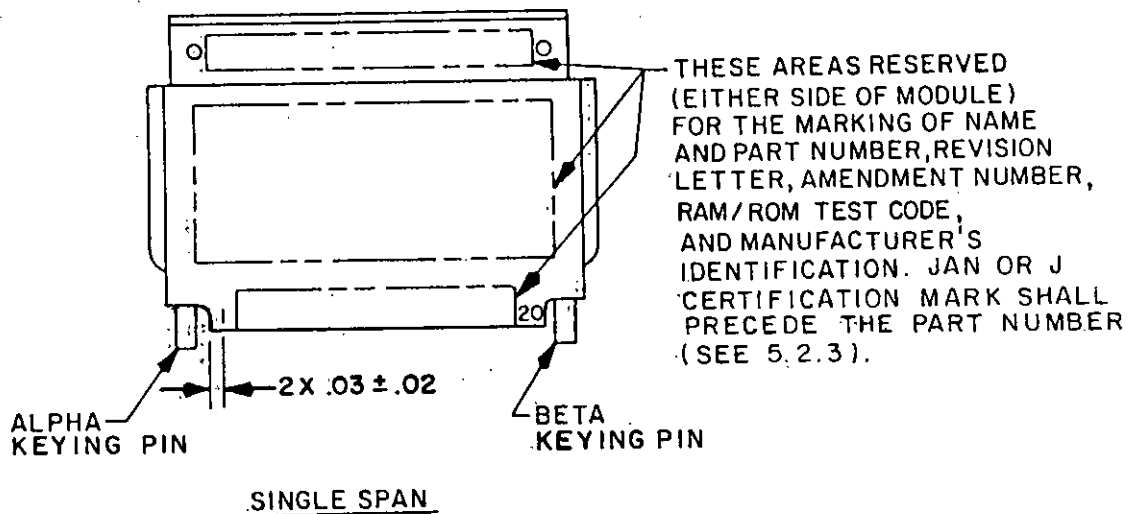
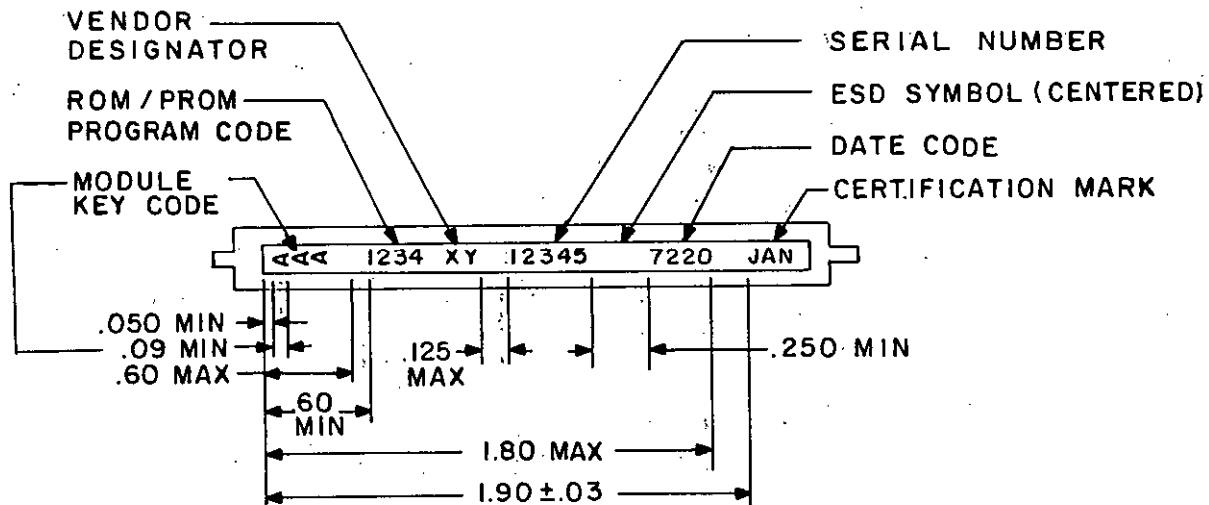
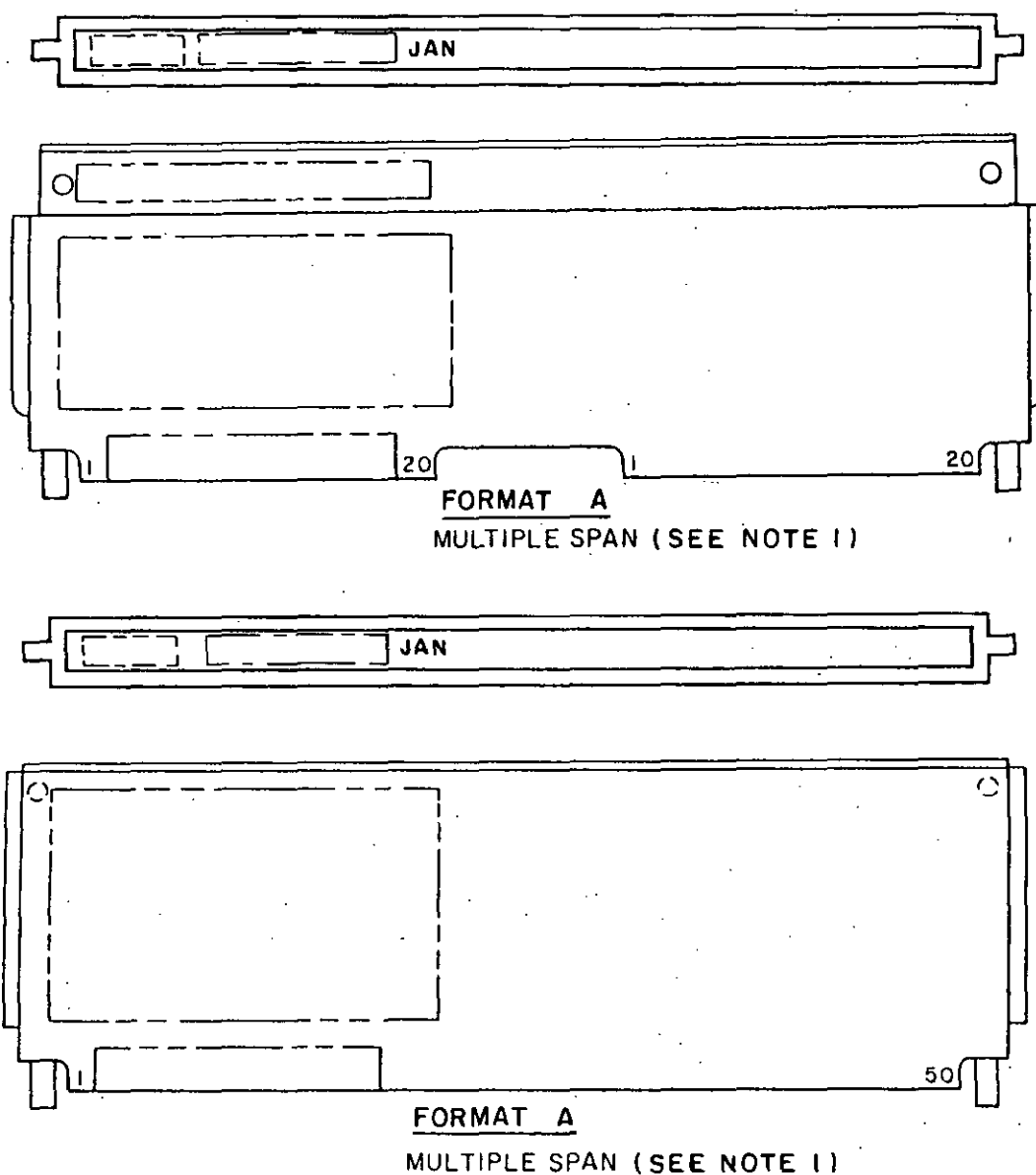


FIGURE 13. Extractor fin identification.

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APPENDIX AFIGURE 14. Module marking areas.

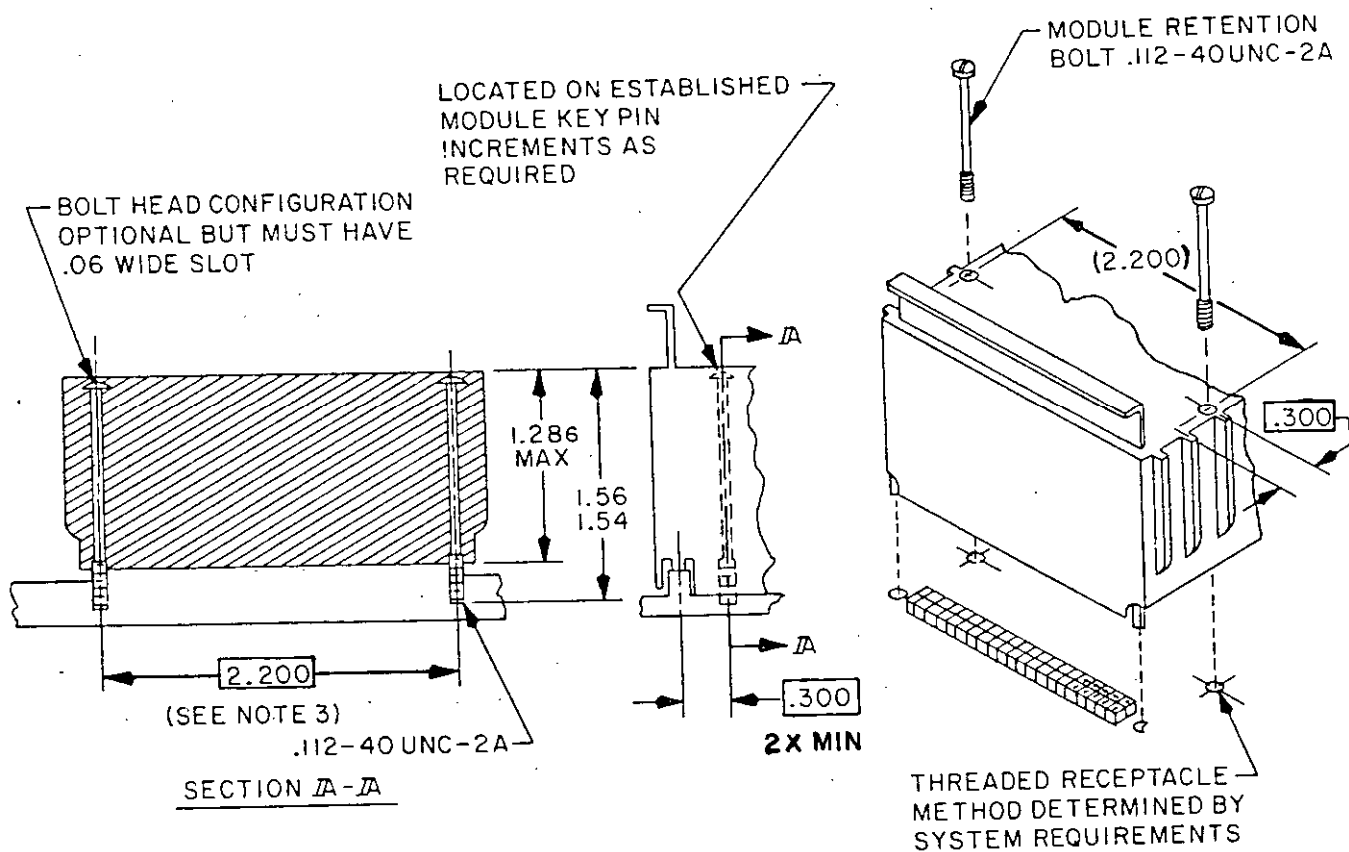
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Inches	mm	Inches	mm
.02	0.5	.250	6.35
.03	0.8	.60	15.2
.050	1.27	1.80	45.7
.09	2.3	1.90	48.3
.125	3.18		

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.

FIGURE 14. Module marking areas - Continued.

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Inches	mm
.06	1.5
.300	7.62
1.286	32.66
1.54	39.1
1.56	39.6
2.200	55.88

NOTES:

1. When holddown screws are in their secured position, the head of the screw shall be within the 1.286 inch (32.66 mm) dimension.
2. Holddown screws, when required, shall be provided at both the alpha and beta ends of the module increment in which they are located.
3. Clearance holes .142 inch (3.61 mm) diameter minimum $\oplus \varnothing .010 \text{ (M)} \text{ E}$ (0.25 mm), 2 holes, reference to figure 7.
4. Dimensions are in inches.
5. Metric equivalents are given for general information only.

FIGURE 15. Module retention bolt interface.

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APPENDIX B

DESIGN REQUIREMENTS FOR FORMAT B MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the design requirements for format B modules to be used in the Standard Electronic Modules Program (SEMP).

20. REFERENCED DOCUMENTS

20.1 Government documents. The following document forms a part of this appendix to the extent specified.

SPECIFICATION

MILITARY

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

(Copies of the specification required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

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 VI.

30.2 Thermal requirements. All 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. 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 .10 pound mass per minute (0.008 kilogram per second) for each "A" incremental thickness per module when tested in a duct size of 2.00 inches (50.8 mm) high and .315 inch (8.00 mm) wide. A maximum airflow rate of .25 pound mass per minute (0.002 kilogram per second) for each "A" incremental thickness per module shall be used when tested in a duct size of 2.00 inches (50.8 mm) high and .413 inch (10.5 mm) wide. Duct width shall be increased by .300 inch (7.62 mm) for each additional module thickness increment. For direct air impingement cooling, the maximum allowable static pressure loss shall be .11 inch (2.3 mm) of water across a single span module and .30 inch (7.6 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 (69.6 mm), a thickness of .290 inch (7.37 mm) and is 1.95 inches (49.5 mm) high including keying pins. Module may increase in span, thickness, or simultaneously in both span and thickness. For multiple increment modules, span shall be increased in 3.000 inches (76.20 mm) increments and thickness shall be increased in .300 inch (7.62 mm) increments as shown in table VI. All module configurations and size designations shall conform to the span and thickness matrix of table VI. Dimensions and tolerances shall be as specified on figures 17 and 18. Plate mounted modules shall be in accordance with figure 19 and sub-plate mounted modules shall be in accordance with figure 20.

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40.1.1 Circuitry. External circuitry and components shall be contained within an area defined by the following: A minimum of .050 inch (1.27 mm) inward on each side from two vertical parallel lines established by the CC dimension and a maximum of 1.645 inches (41.78 mm) measured vertically from the interface plane (see figure 17). The printed-wiring board shall be further reduced by the crosshatched area shown on figure 17 to allow for insertion of the module extractor and prevent component damage.

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 or both.

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 in accordance with 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 in accordance with 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 be located within the last two module increments and it shall meet the configuration requirements of figure 22. All module extractor fins shall have extractor holes in accordance with figures 17 and 18. 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 be capable of withstanding 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 in a direction perpendicular to the plane of the fin without detrimental effect to the mechanical or electrical properties of the module. During the time the torque is applied, the module shall be rigidly supported within a zone between the interface plane and 0.5 inch (13 mm) above the interface plane.

40.1.2.6 Fin cantilever load. The fin shall be capable of withstanding 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 without detrimental effect to the fin structure.

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 18.

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40.1.4 Module connector. The basic 1A module connector shall have either 20 or 40 metal bayonet-type contact pins. Multiple increment modules may have more contact pins with the quantity increasing in increments of 20 contact pins. Unused rows of contact pins need not be present in the connector but any row of 20 pins shall be complete. All connectors shall conform to the requirements specified herein and MIL-C-28754. All double span modules shall use the 100-pin 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 18. 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 21, provides a means for complete identification of any contact pin on the module. All 100-pin connectors shall have the contacts numbered from 1 to 100 as shown on figure 21.

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 21, 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. All connectors located within each span are designated with that span number (see figure 21). Span identification is not required for use of 100 pin 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 24. Pin numbers 21 and 40 need not be identified when the contacts are not in the module or when in multiple thickness modules pins 21 and 40 are located in the increment A. In multiple thickness modules when pins 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-pin connector, the module shall have contacts identified by numbers 1, 50, 51, and 100 marked at locations shown on figure 24.

40.1.4.6 Contact pin location. The location of contact pins 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 applied along the contact length in either direction. The total computed force shall be applied simultaneously to all module connector pins 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 be capable of withstanding 500 cycles of mating and unmating with no degradation of module performance.

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40.1.5.3 Inclination. The module shall be capable of continuous operation while being inclined at the rate of 5 to 7 cycles per minute in all vertical planes to an angle of 45 degrees from vertical.

40.1.5.4 Module retention. On multiple increment modules, the use of slotted holddown screws is permitted. Holes for the module holddown screws shall be located at the .300 inch (7.62 mm) thickness increment centerline and the 2.200 inches (55.88 mm) keying pin dimension as shown on figure 25. The hole configuration is optional but shall provide a captive feature for .112-40 UNC-2A holddown screws which will permit a minimum of .015 inch (0.38 mm) radial float. The captive screws shall extend .200 to .270 inch (5.08 to 6.86 mm) beyond the interface plane with the .112 inch (2.84 mm) diameter extension below the interface plane being fully threaded. Captive means shall ensure the screw does not interfere with the insertion and extraction of the module. Holddown screws shall not be located in the first module connector increment. Holddown screws 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 grams).
- c. Module exceeds 12 increments in thickness.

40.1.5.5 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 3).

40.1.5.6 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.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that critical component temperatures (CCI and TCCI) 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 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 no load connected to the output. The power for analog modules is to be determined with load connected to the output.

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40.2.3 Component temperatures. The following requirements for critical component temperature (CCT) and transient critical component temperature (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.

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

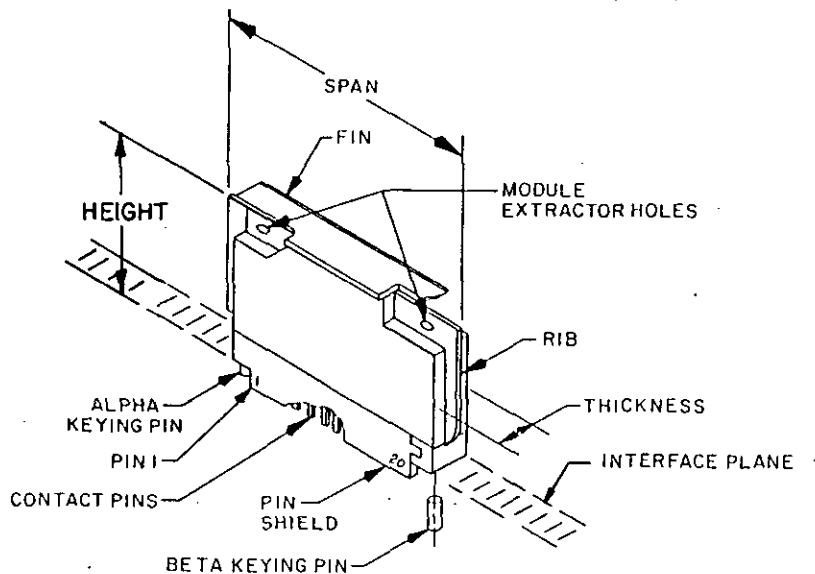


FIGURE 16. Module outline.

TABLE VI. Module span and thickness increments. 3/ 4/

Span 1/ (3.00 inch (76.2 mm) increments)			Thickness 2/									
Span desig	DIM	INCH	A .290 (7.37)	B .590 (14.99)	C .890 (22.61)	D 1.190 (30.23)	E 1.490 (37.85)	F 1.790 (45.47)	G 2.090 (53.09)	H 2.390 (60.71)	J 2.690 (68.33)	K 2.990 (75.95)
1	2.74 (69.6)		1A	1B	1C	1D	1E	1F	1G	1H	1J	1K
2	5.74 (148.8)		2A	2B	2C	2D	2E	2F	2G	2H	2J	2K
3	8.74 (222.0)		3A	3B	3C	3D	3E	3F	3G	3H	3J	3K

L 3.290 (83.57)	M 3.590 (91.19)	N 3.890 (98.81)	P 4.190 (106.43)	R 4.490 (114.05)	S 4.790 (121.67)	T 5.090 (129.29)	U 5.390 (136.91)	V 5.690 (144.53)	W 5.990 (152.15)	Y 6.290 (159.77)	Z 6.590 (167.3)
1L	1M	1N	1P	1R	1S	1T	1U	1V	1W	1Y	1Z
2L	2M	2N	2P	2R	2S	2T	2U	2V	2W	2Y	2Z
3L	3M	3N	3P	3R	3S	3T	3U	3V	3W	3Y	3Z

1/ Span is measured across the ribs.

2/ Each letter is .300 inch (7.62 mm) greater than the previous letter with "A" equal to .290 inch (7.37 mm) maximum.

3/ Dimensions are in inches.

4/ Metric equivalents are given for general information only.

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APPENDIX BTABLE VII. Module span and thickness dimensions.
(see figures 17 and 18 for details). 1/ 2/

Span	Dimensions						
	AA ±.01 (0.3)	BB ±.01 (0.3)	CC +.005 (0.13) -.075 (1.90)	DD basic	EE ±.01 (0.3)	FF basic	KK ±.01 (0.3)
1	2.32 (58.9)	1.89 (48.0)	2.440 (61.98)	2.200 (55.88)	2.74 (69.6)	.150 (3.81)	1.49 (37.8)
2	5.32 (135.1)	4.89 (124.2)	5.440 (138.18)	5.200 (132.08)	5.74 (145.8)	.150 (3.81)	4.49 (114.0)
3	8.32 (211.3)	7.89 (200.4)	8.440 (214.38)	8.200 (208.28)	8.74 (222.0)	.150 (3.81)	7.49 (190.2)

Thickness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
A	.290 (7.37)	.220 (5.59)	0
B	.590 (14.99)	.520 (13.21)	.300 (7.62)
C	.890 (22.61)	.820 (20.83)	.600 (15.24)
D	1.190 (30.23)	1.120 (28.45)	.900 (22.86)
E	1.490 (37.85)	1.420 (36.07)	1.200 (30.48)
F	1.790 (45.47)	1.720 (43.69)	1.500 (38.10)
G	2.090 (53.09)	2.020 (51.31)	1.800 (45.72)
H	2.390 (60.71)	2.320 (58.93)	2.100 (53.34)
J	2.690 (68.33)	2.620 (66.55)	2.400 (60.96)
K	2.990 (75.95)	2.920 (74.17)	2.700 (68.58)
L	3.290 (83.57)	3.220 (81.79)	3.000 (76.20)

Thickness letter	Dimensions		
	GG maximum	HH minimum	JJ basic
M	3.590 (91.19)	3.520 (89.41)	3.300 (83.82)
N	3.890 (98.81)	3.820 (97.03)	3.600 (91.44)
P	4.190 (106.43)	4.120 (104.65)	3.900 (99.06)
R	4.490 (114.05)	4.420 (112.27)	4.200 (106.68)
S	4.790 (121.67)	4.720 (119.89)	4.500 (114.30)
T	5.090 (129.29)	5.020 (127.51)	4.800 (121.92)
U	5.390 (136.91)	5.320 (135.13)	5.100 (129.54)
V	5.690 (144.53)	5.620 (142.75)	5.400 (137.16)
W	5.990 (152.15)	5.920 (150.37)	5.700 (144.78)
Y	6.290 (159.77)	6.220 (157.99)	6.000 (152.40)
Z	6.590 (167.39)	6.520 (165.61)	6.300 (160.02)

1/ Dimensions are in inches.

2/ Metric equivalents are given for general information only.

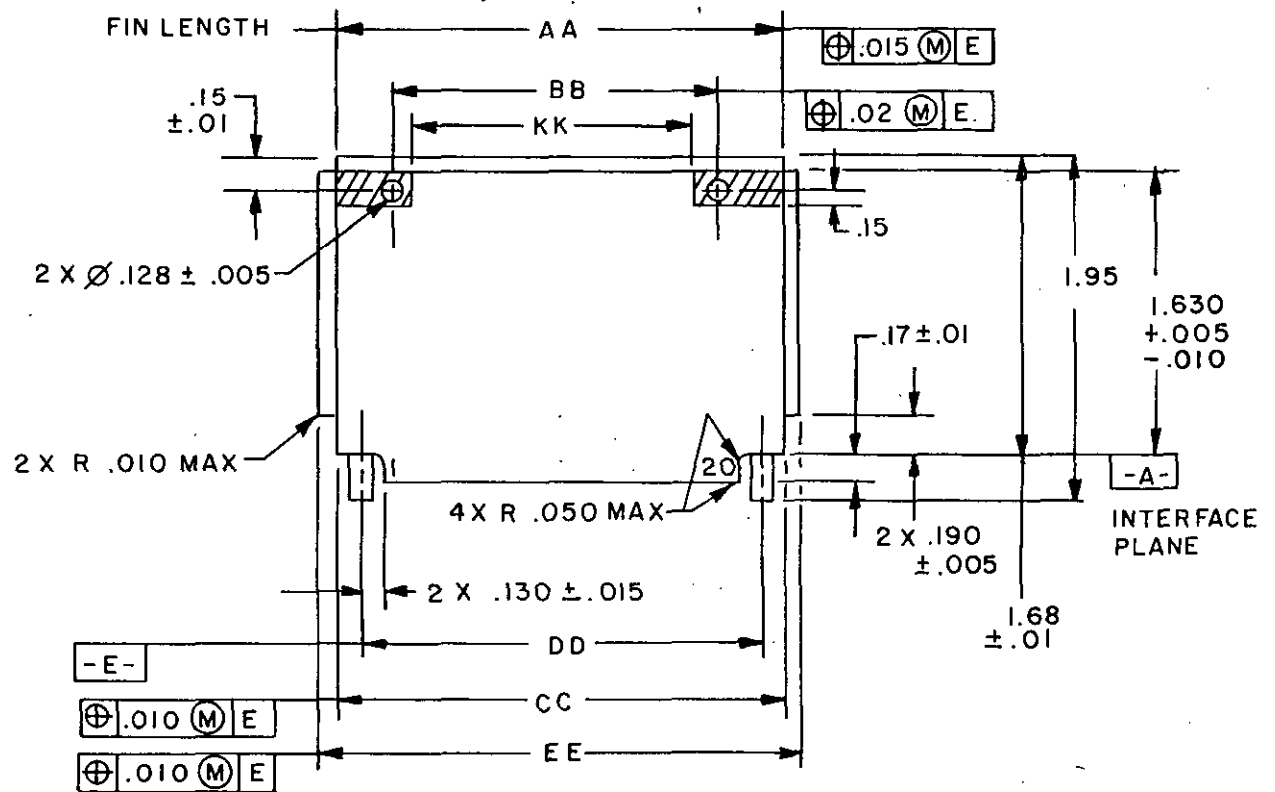
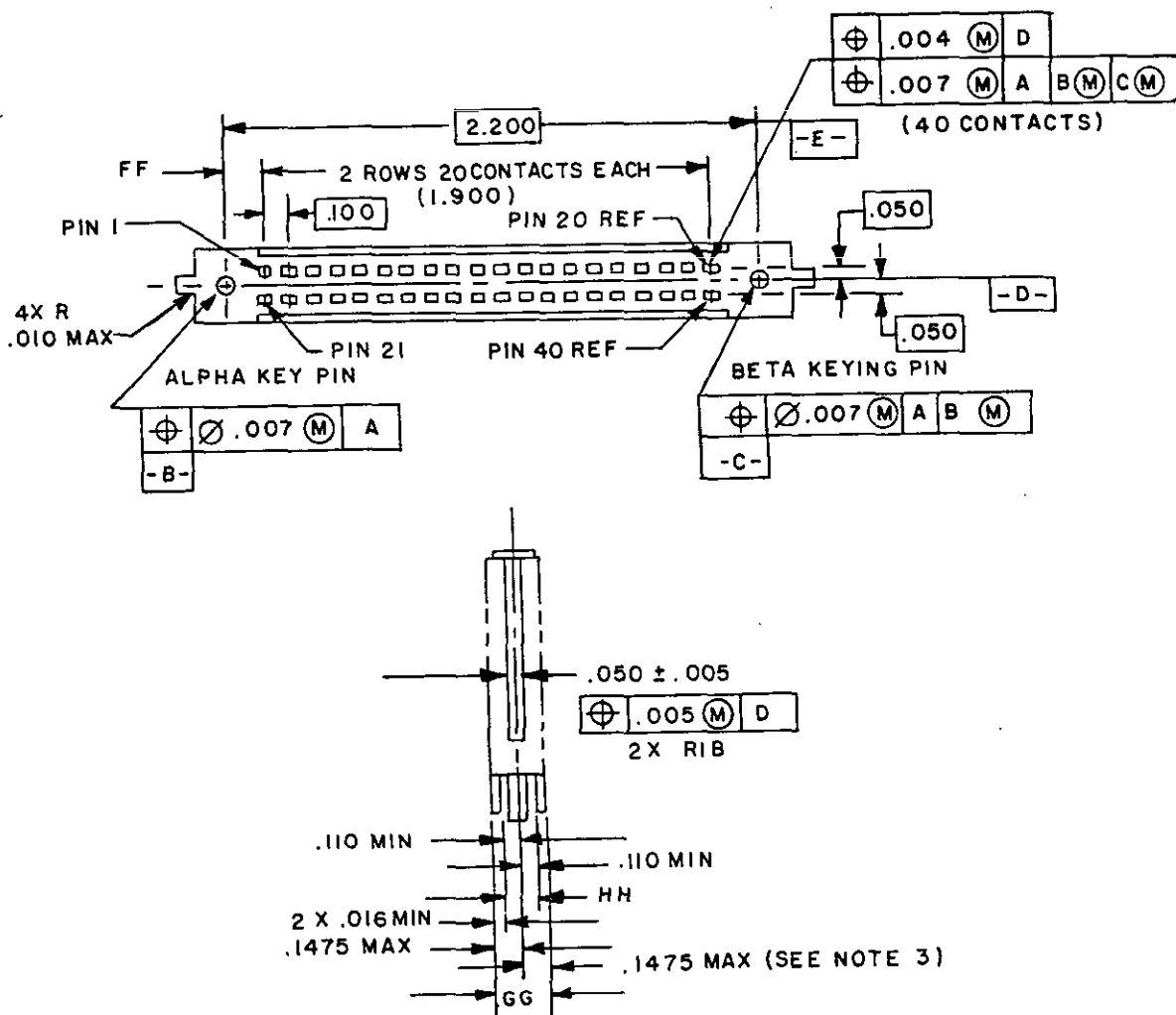


FIGURE 17. Module basic size outline.

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Inches	mm	Inches	mm	Inches	mm	Inches	mm
.004	0.10	.016	0.41	.130	3.30	1.68	42.7
.005	0.13	.02	0.5	.1475	3.746	1.900	48.26
.007	0.18	.050	1.27	.15	3.8	1.95	49.5
.010	0.25	.100	2.54	.17	4.3	2.200	55.88
.01	0.3	.110	2.79	.190	4.83		
.015	0.38	.128	3.25	1.630	41.40		

NOTES:

1. See table VII for letter dimensions.
2. The .1475 inch (3.746 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.

FIGURE 17. Module basic size outline - Continued.

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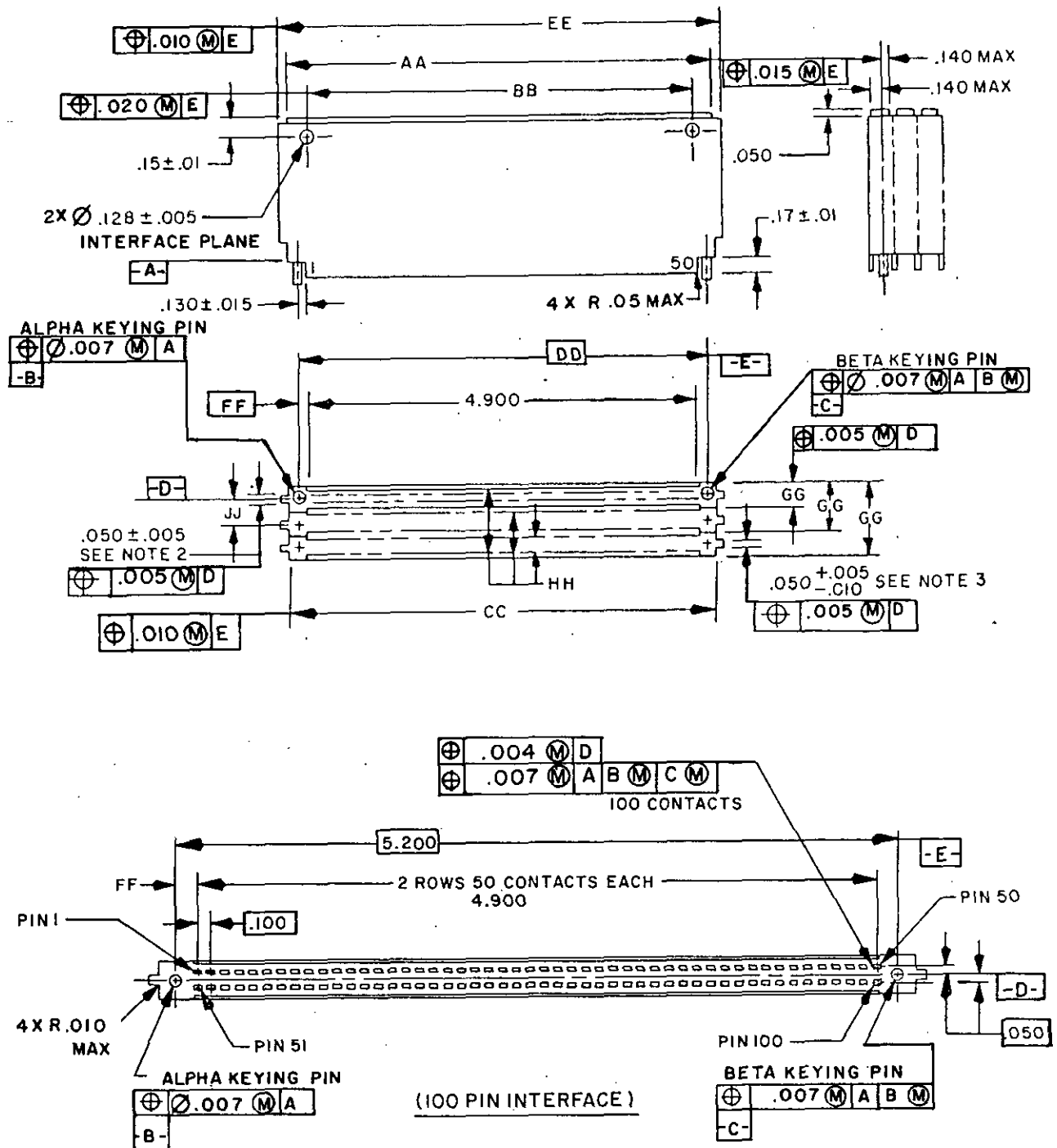
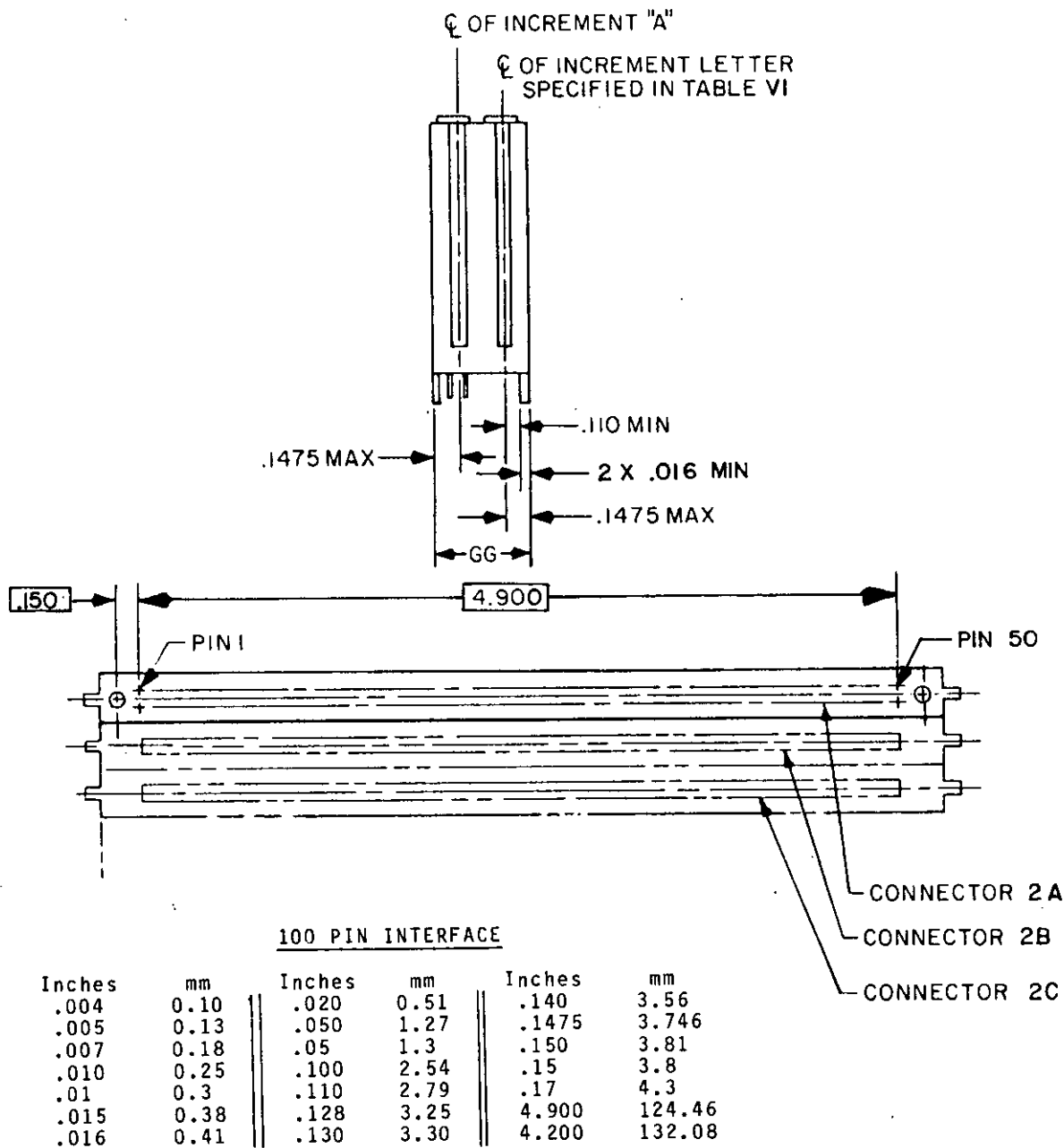


FIGURE 18. Multiple increment module outline.

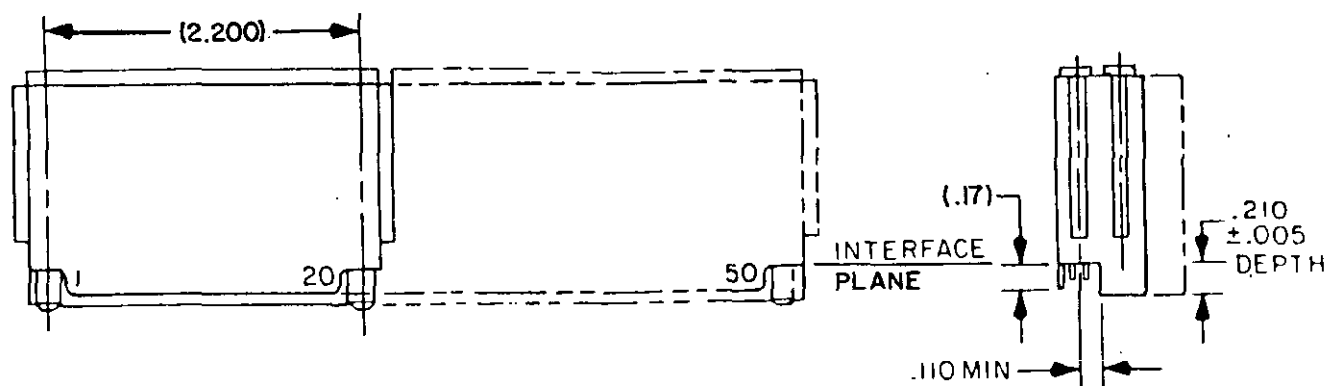
MIL-STD-1389C
APPENDIX BFIGURE 18. Multiple increment module outline - Continued.

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NOTES:

1. Module pin shields are only required for the external protection of contact pins and are not required for module increments which do not contain contact pins.
2. The $.050 \pm .005$ inch ($1.27 \pm .013$ mm) dimension applies to the first module increment only.
3. The $.050 + .005, -.010$ inch ($1.27 + .013, -.025$ mm) dimension applies to all module increments except the first.
4. The $.1475$ inch (3.746 mm) maximum indicates the maximum eccentricity allowed on either side of centerline, but not both. Dimension GG maximum governs.
5. See table VII 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.

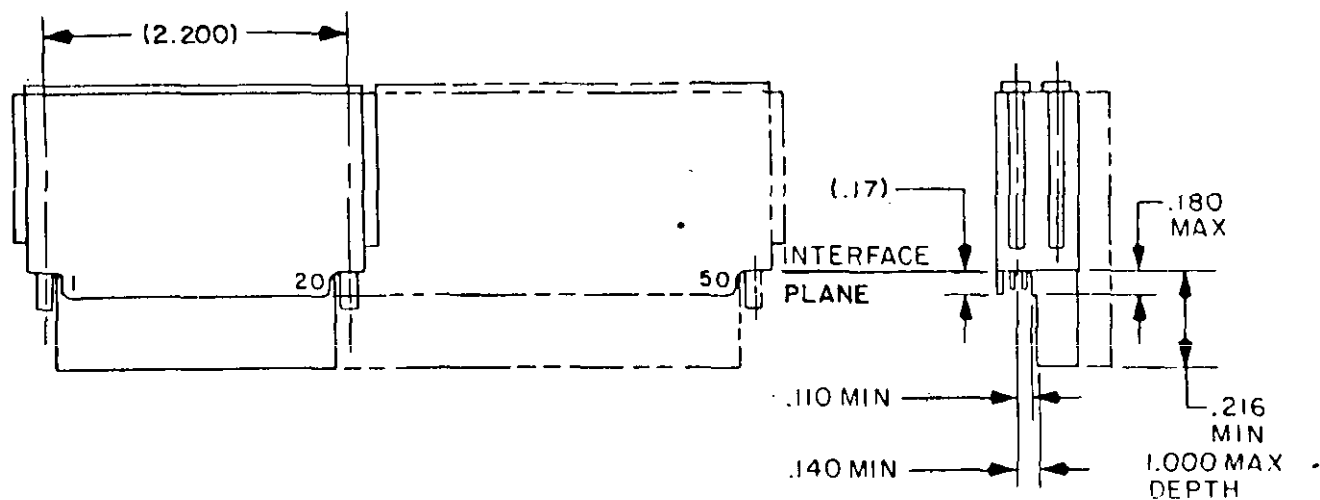
FIGURE 18. Multiple increment module outline - Continued.

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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.

Inches	mm
.005	0.13
.110	2.79
.17	4.3
.210	5.33
2.200	55.88

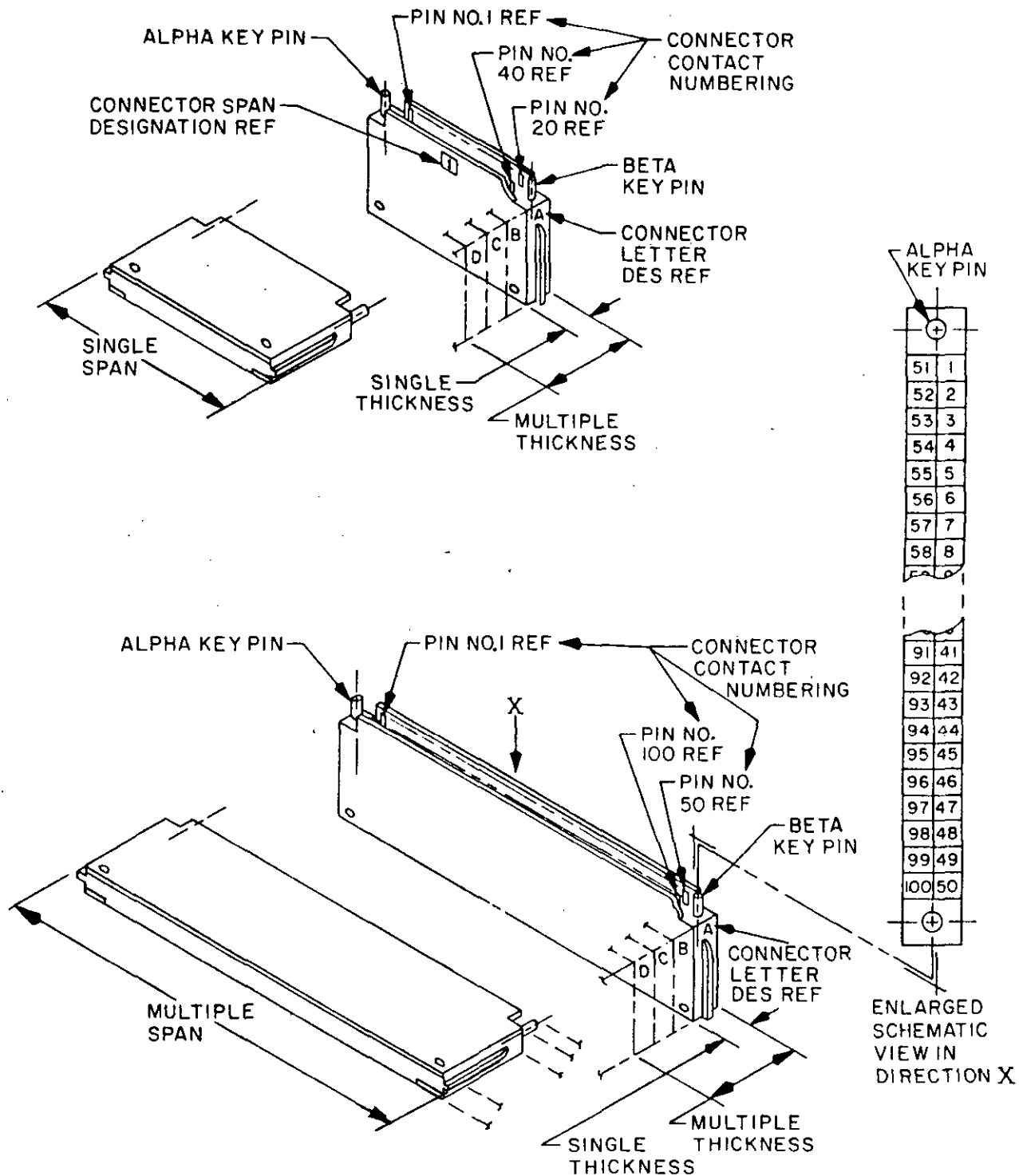
FIGURE 19. Plate mounted module outline.

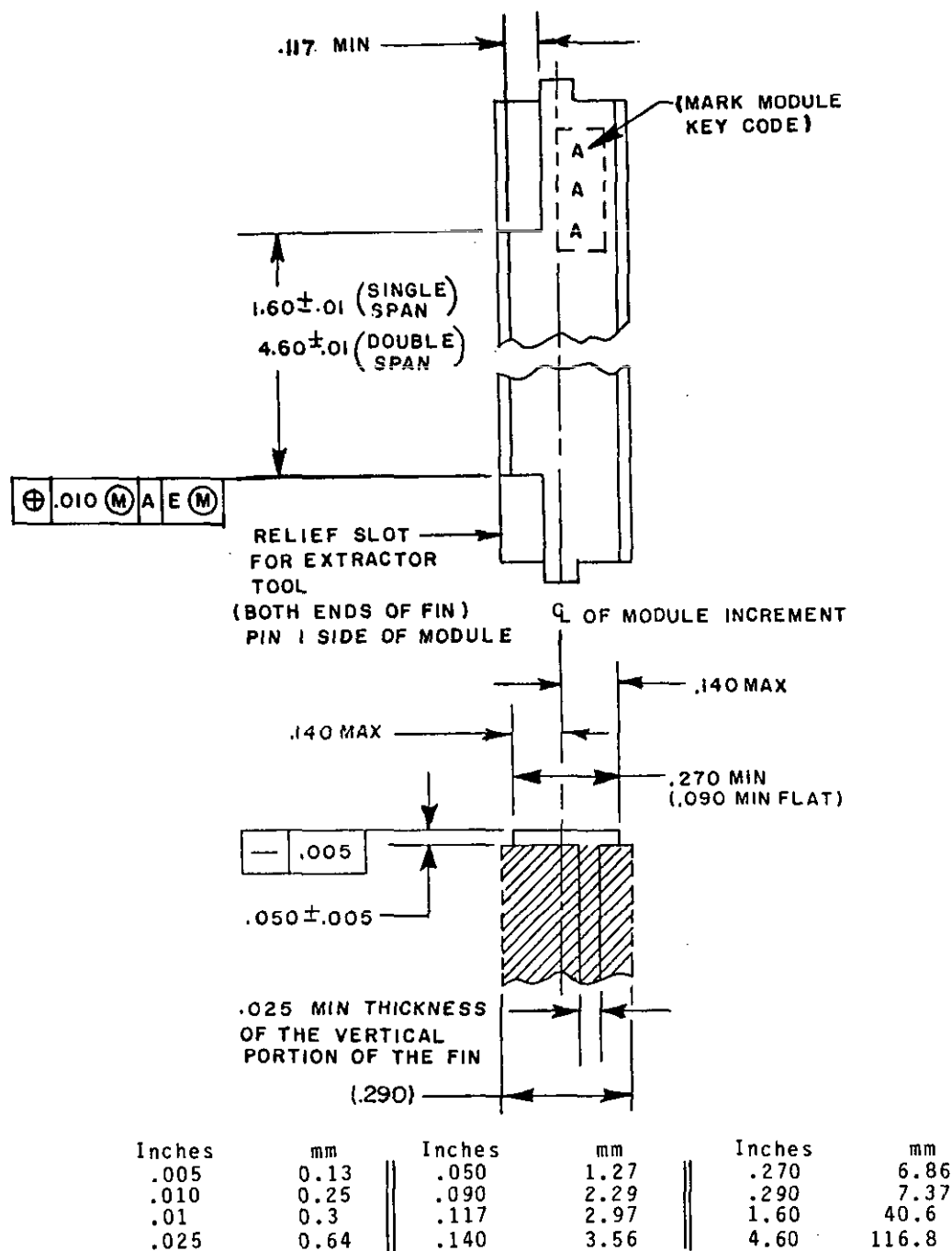
NOTES:

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.

Inches	mm
.110	2.79
.140	3.56
.17	4.3
.180	4.57
.216	5.49
1.000	25.40
2.200	55.88

FIGURE 20. Sub-plate mounted module outline.

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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.

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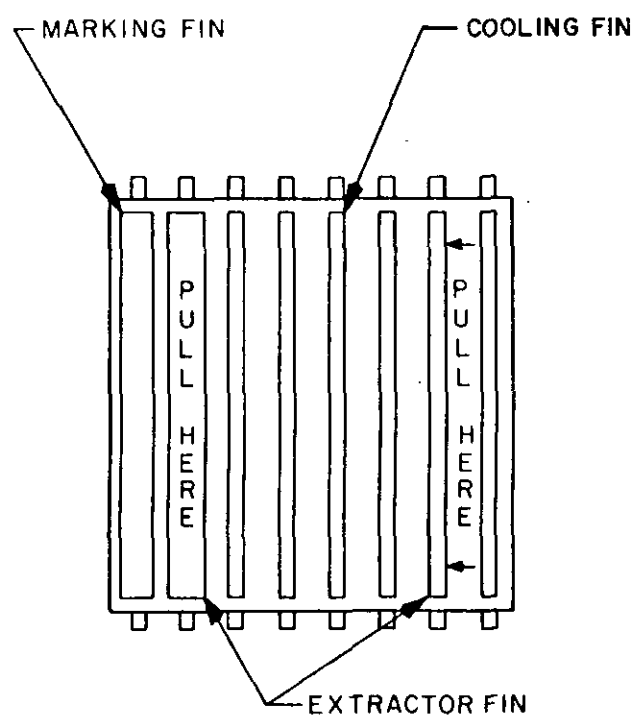
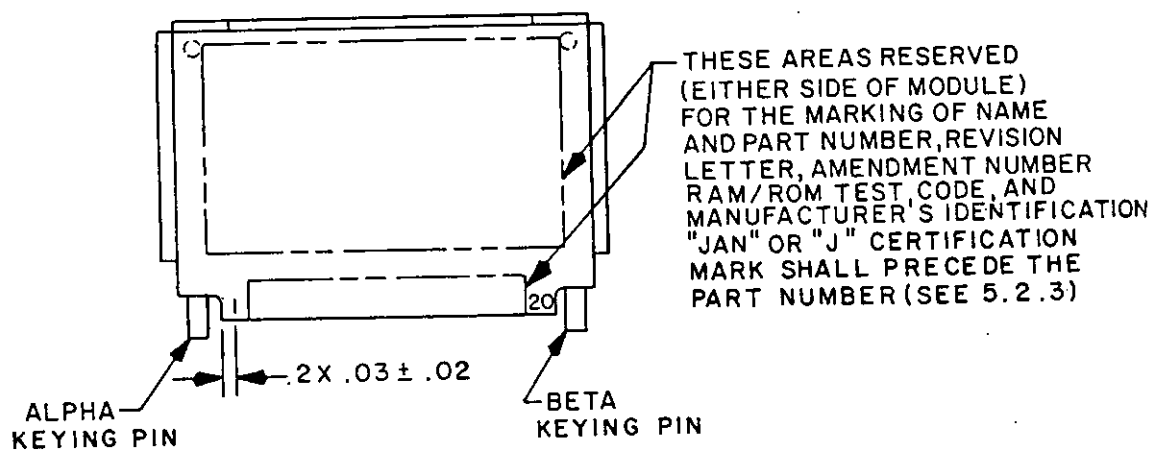
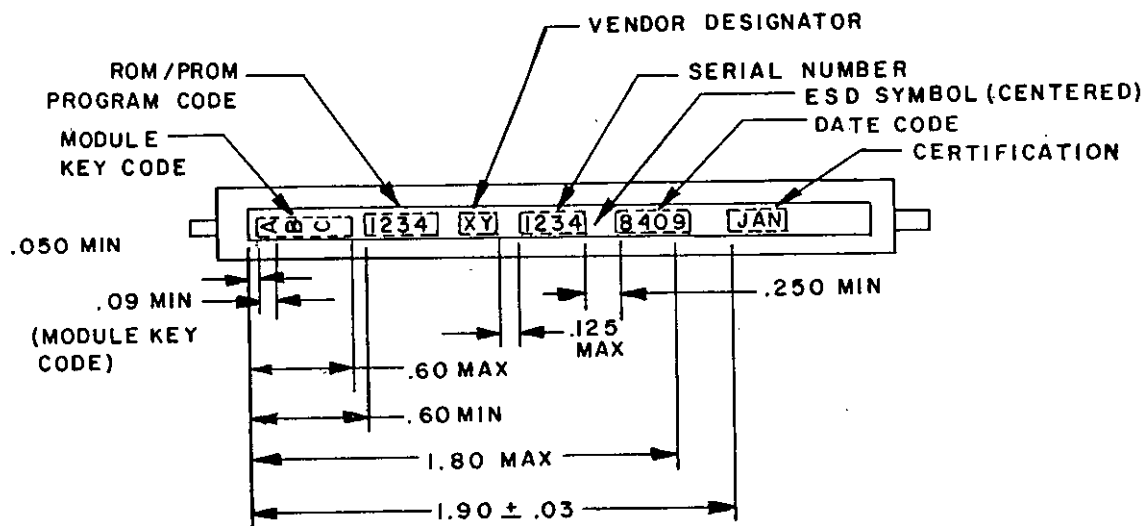
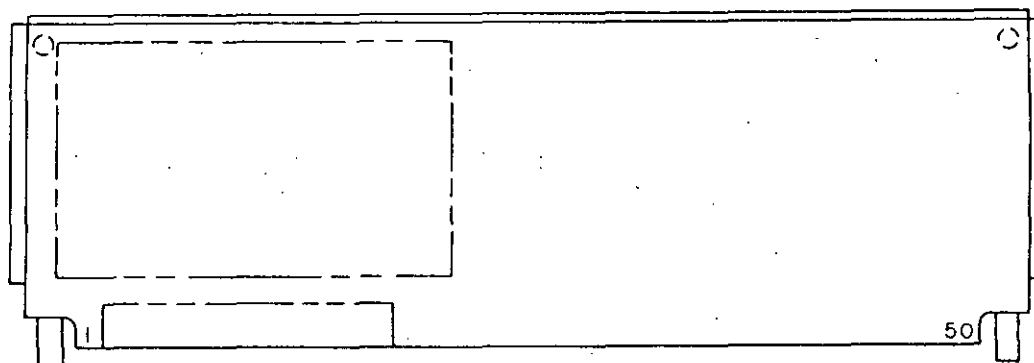
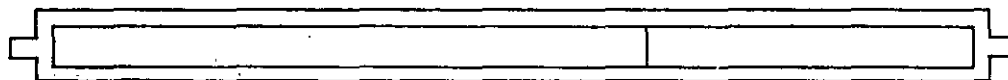


FIGURE 23. Extractor fin identification.

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APPENDIX BSINGLE SPANFIGURE 24. Module marking areas.

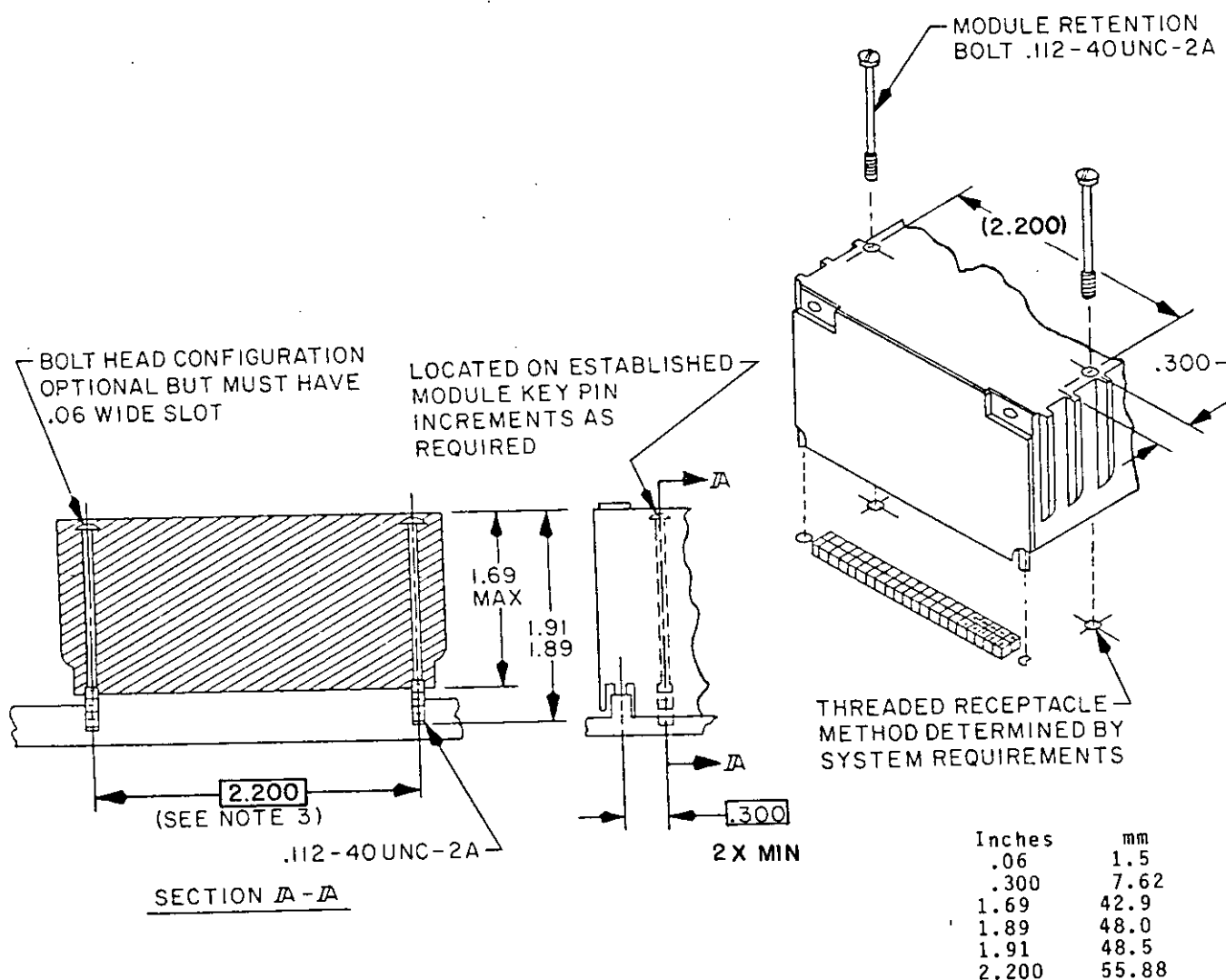
MIL-STD-1389C
APPENDIX BMULTIPLE SPAN (SEE NOTE 1)

Inches	mm		Inches	mm
.02	0.5		.250	6.35
.03	0.8		.60	15.2
.050	1.27		1.80	45.7
.09	2.3		1.90	48.3
.125	3.18			

NOTES:

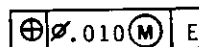
1. All marking performed on a multiple span module shall be the same and located in the same areas as a single span module.
2. Dimensions are in inches.
3. Metric equivalents are given for general information only.

FIGURE 24. Module marking areas - Continued.

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NOTES:

1. When holddown screws are in their secured position, the head of the screw shall be within the 1.69 inch (42.9 mm) dimension.
2. Holddown screws, when required, shall be provided at both the alpha and beta ends of the module increment in which they are located.
3. Clearance holes .142 inch (3.61 mm) diameter minimum (0.25 mm), 2 holes, reference to figure 17.
4. Dimensions are in inches.
5. Metric equivalents are given for general information only.

FIGURE 25. Module retention bolt interface.

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APPENDIX C

DESIGN REQUIREMENTS FOR FORMAT C MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the design requirements for format C modules to be used in the Standard Electronic Modules Program (SEMP).

20. REFERENCED DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified.

SPECIFICATIONS

MILITARY

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

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

(Copies of the specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.

30. GENERAL REQUIREMENT

30.1 Mechanical configuration requirements. The basic mechanical configurations are specified on figures 26 and 27 with incremental growth in thickness specified in table VIII.

30.1.1 Lateral displacement. The module may be designed to provide a lateral displacement between the module frame and connector of $\pm .006$ inch (0.15 mm) minimum from center of the two guide rib profiles. The maximum force required to displace the connector shall be 5 pounds (22.2 newtons). 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 VIII. The guide rib locational tolerance from datum D is not applicable if this option is exercised.

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

40. DETAIL REQUIREMENTS

40.1 Configuration. The basic size module has a span of 5.88 inches (149.4 mm) maximum, a thickness of .280 inch (7.11 mm) maximum and is 4.06 inches (103.1 mm) maximum in total height. Module may increase in thickness in accordance with table VIII. Dimensions and tolerances shall be as specified on figure 27.

40.1.1 Circuitry. The module shall have a minimum clearance of .015 inch (0.38 mm) around all edges of the substrate or printed-wiring board. The printed-wiring board shall be further reduced to allow for insertion of the module extractor and prevent component damage during module extraction.

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

- a. Module identification.
- b. Module insertion.
- c. Component protection.
- d. Test point access.

40.1.2.1 Module identification. The module identification header shall have the configuration and marking as specified on figure 29.

40.1.2.2 Module insertion. The header structure shall be capable of withstanding 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.

40.1.2.4 Test point access. The module header shall provide readily accessible test points, however, all final electrical acceptable testing shall be performed through the input/output (I/O) connector pins on the module. All individual modules shall be designed such that the removal of the header shall in no way effect the proper functioning of the module.

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 a minimum of two ribs: One located at the alpha end and one located at the beta end of the module. Modules of .6 inch (15 mm) pitch may have additional ribs in their thickness increments. The ribs if present shall be located on .300 inch (7.62 mm) centers from the basic rib location as shown on figure 27.

40.1.3.2 Module extractor interface. Modules shall have a set of two extractor holes located as shown on figure 27. Modules having a thickness of 2.090 inches (53.09 mm) or greater shall have two sets of extractor holes. The second set shall be located within the last .3 inch (8 mm) of the module and meet the location requirements shown on figure 27.

40.1.4 Module connector. The basic module connector shall have two rows of 50 metal bayonet type contact pins. Modules of .4, .5, and .6 inch (10, 13, and 15 mm) pitch may increase contact pin quantity to three, four, and five rows of 50 contact pins with all rows of 50 pins to be complete. All connectors shall conform to the requirements specified herein and in MIL-C-28754.

40.1.4.1 Connector location. The location of connectors shall be as shown on figure 27. Each connector shall have contacts identified by numbers indicating the first and last pin of the row closest to the pin shield as shown on figure 28.

40.1.4.2 Contact pin location. The location of contact pins shall be as shown on figure 28.

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 this standard.

40.1.5 Module mechanical requirements. The following mechanical requirements apply.

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40.1.5.1 Module integrity. Each module, with the connector assembled, shall withstand without damage or separation on 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. The module shall be capable of withstanding a 6 inch-pound (0.68 newton-meter) torque applied in 2 to 10 seconds and maintained 10 to 15 seconds in both directions along the header in a direction perpendicular to the plane of the header without detrimental effect to the mechanical or electrical properties of the module. During the time the torque is applied, the module shall be rigidly supported within a zone between the interface plane and 0.5 inch (13 mm) above the interface plane.

40.1.5.3 Module cantilever load. The module shall be capable of withstanding a force of 2 pounds (9 newtons) applied perpendicular to the header 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 without detrimental effect to the header structure.

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

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 of the ribs shall be 25 microinch (0.00064 mm) or better.

40.1.6.2 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.

40.1.6.3 Aluminum frame plating. All 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.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that critical component temperatures 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 condition. 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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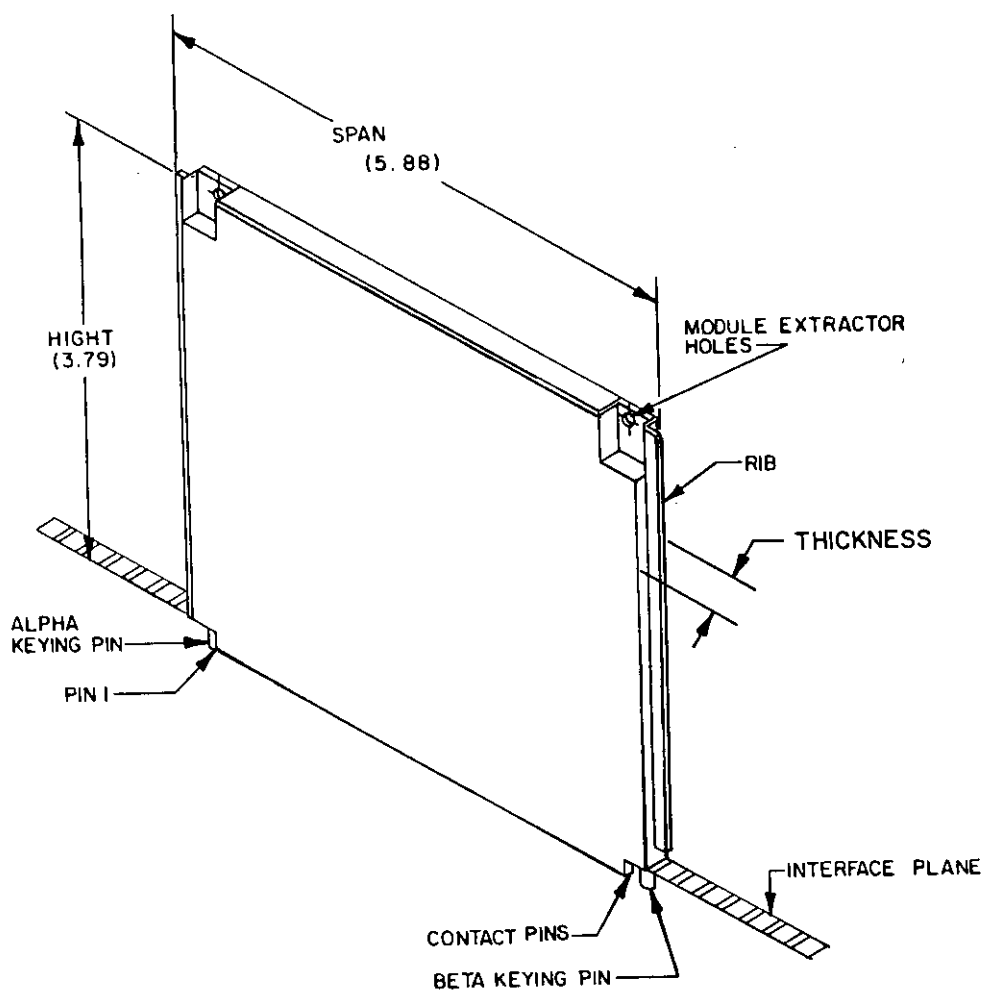
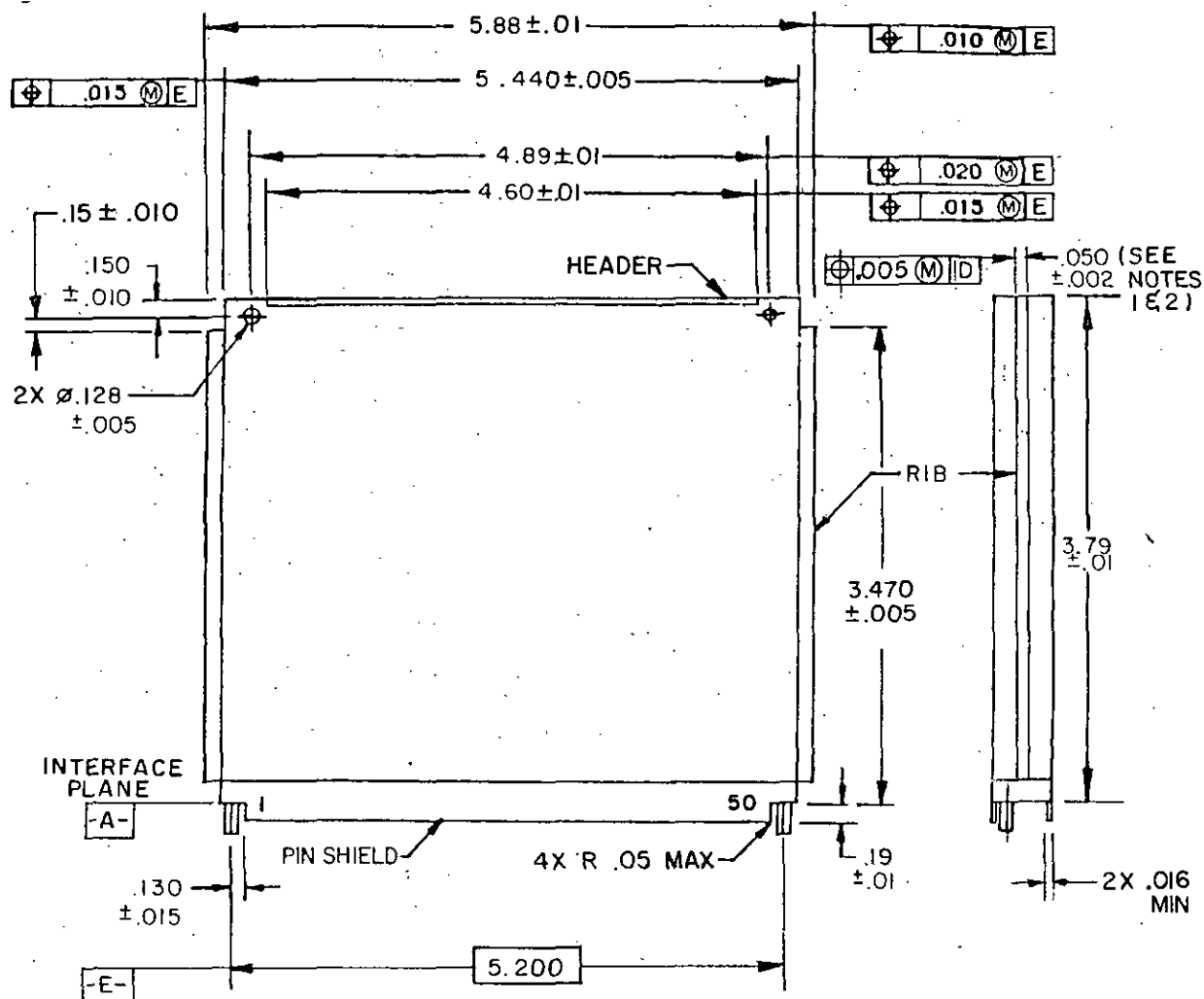


FIGURE 26. Module outline.

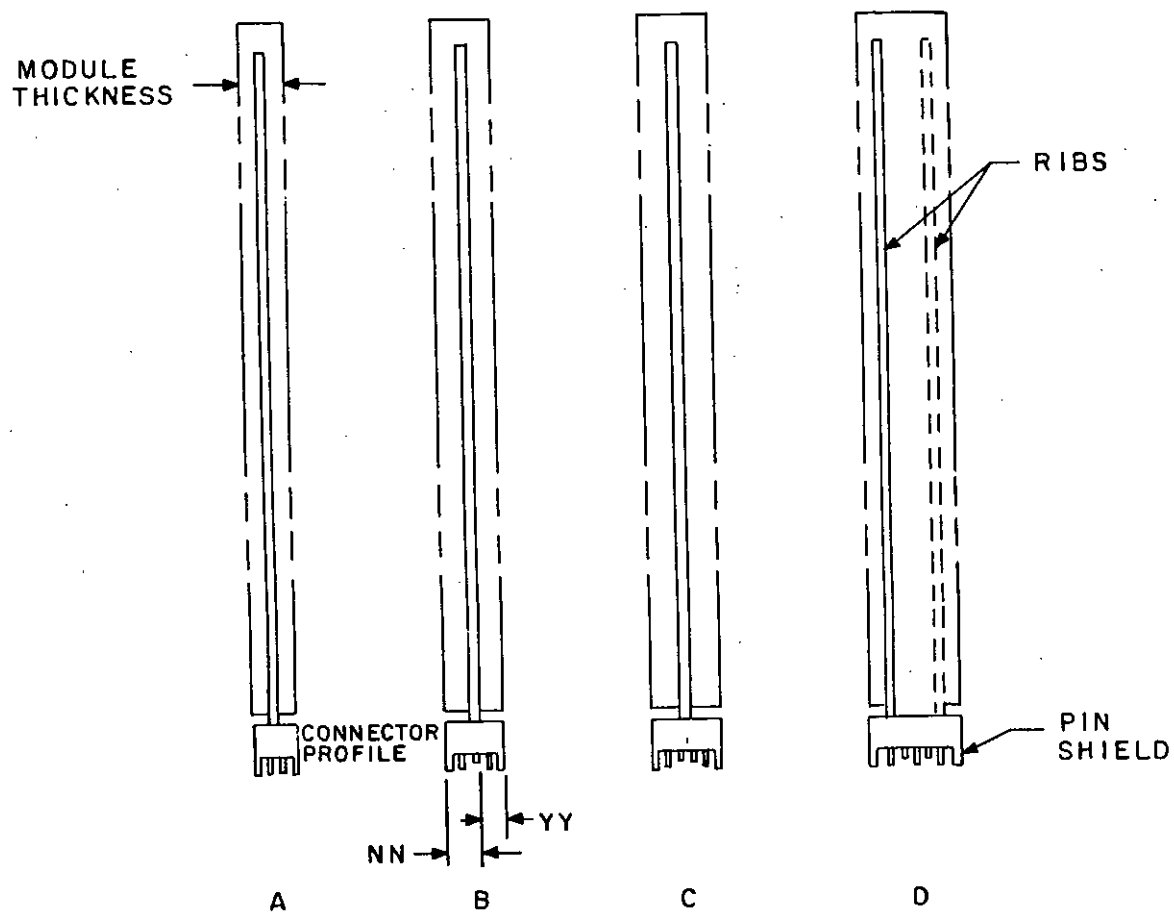
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Inches	mm	Inches	mm	Inches	mm
.002	0.05	.050	1.27	3.470	88.14
.005	0.13	.05	1.3	3.79	96.3
.010	0.25	.128	3.25	4.60	116.8
.01	0.3	.130	3.30	4.89	124.2
.015	0.38	.150	3.81	5.200	132.59
.016	0.41	.15	3.8	5.440	138.18
.020	0.51	.19	4.8	5.88	149.4

NOTES:

1. Rib feature shall be contained within .055 inch (1.40 mm) maximum zone.
2. Rib surface finish of 25 microinch (0.00064 mm) or better.
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.

FIGURE 27. Module configurations.

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40.2.3 Component temperatures. The following requirements for critical component temperature (CCT) and transient critical component temperature (TCCT) apply.

40.2.3.1 CCT. The CCT for semiconductor devices dissipating 2.5 watts or less typical power shall be 80°C junction for classes I and III and 105°C junction for classes II and IV. For semiconductors dissipating more than 2.5 watts typical power, the CCT may increase 15°C/watt or a maximum of 15°C above that specified for less than 2.5 watt 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.

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

TABLE VIII. Module growth. 4/ 5/

Thickness	A	B	C	D 1/
Module pitch 2/	.3 (8 mm)	.4 (10 mm)	.5 (13 mm)	.6 (15 mm)
Maximum module thickness	.280 (7.11 mm)	.380 (9.65 mm)	.480 (12.19 mm)	.580 (14.73 mm)
Maximum connector profile	.280 (7.11 mm)	.380 (9.65 mm)	.480 (12.19 mm)	.580 (14.73 mm)
Maximum number of pins	100	150	200	250
Dimension NN (max) 3/	.152 (3.86 mm)	.202 (5.13 mm)	.252 (6.40 mm)	.152 (3.86 mm)
Dimension YY (max) 3/	.152 (3.86 mm)	.202 (5.13 mm)	.252 (6.40 mm)	.452 (11.48 mm)

1/ The .6 inch (15 mm) pitch module configuration can increase in thickness in .3 inch (8 mm) increments with no increase in contact pin count.

2/ Pitch refers to the distance between module centerlines for system packaging purposes.

3/ The dimensions are from the center of the two basic guide rib profiles to locate connector lateral extreme displacement.

4/ Dimensions are in inches.

5/ Metric equivalents are given for general information only.

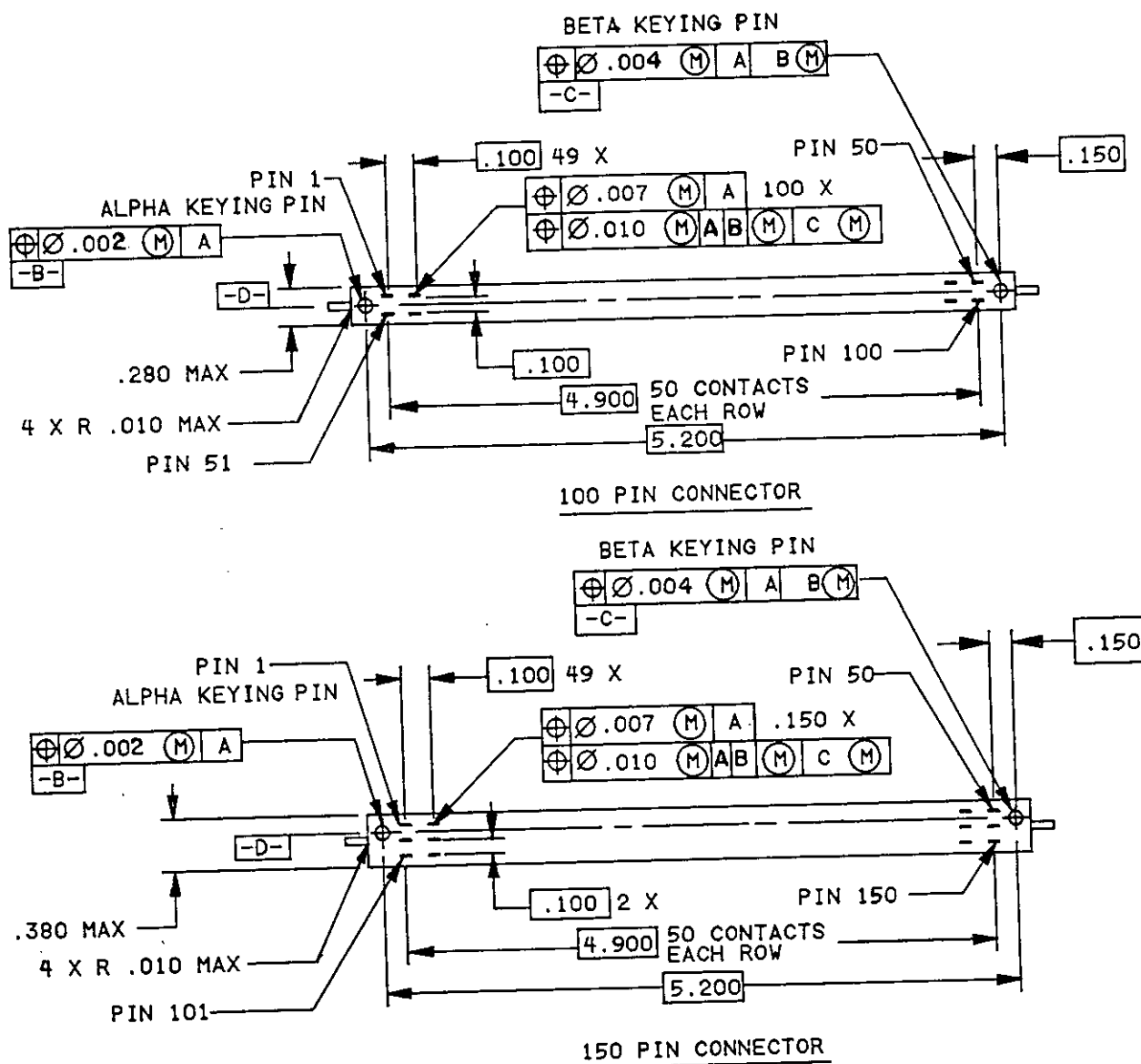
MIL-STD-1389C
APPENDIX C

FIGURE 28. Connector pin assignments.

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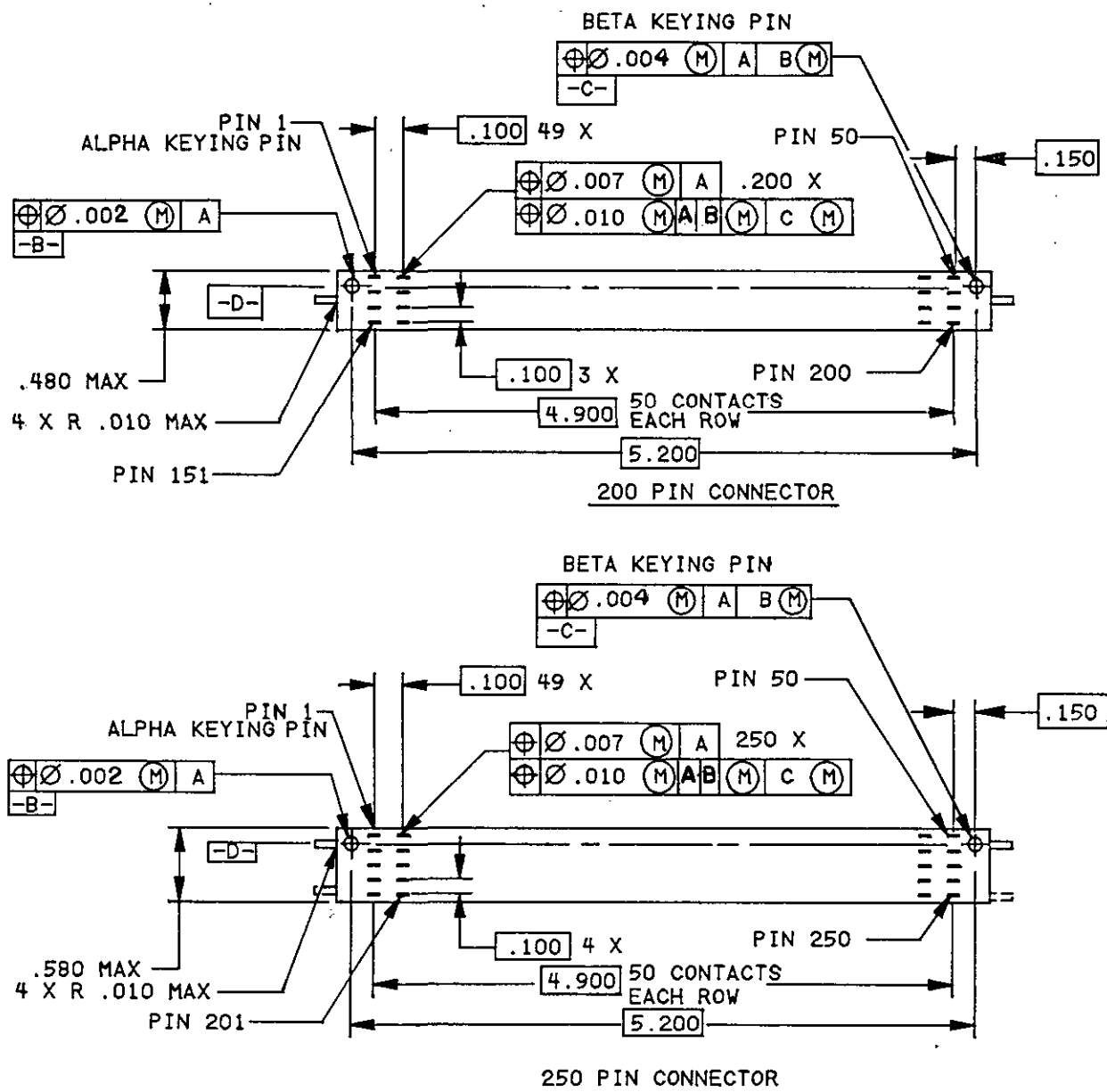


FIGURE 28. Connector pin assignments - Continued.

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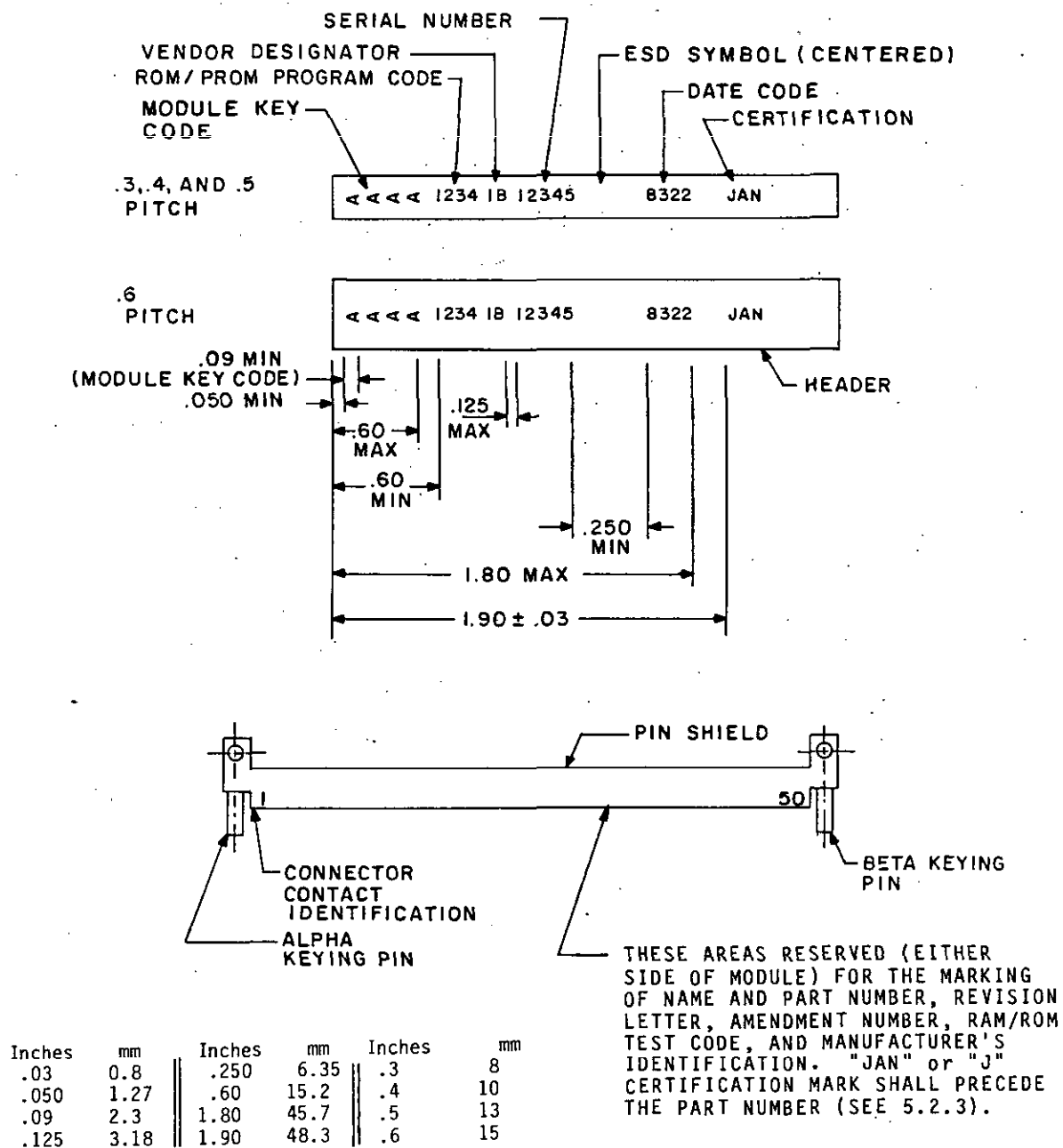
Inches	mm	Inches	mm
.002	0.05	.280	7.11
.004	0.10	.380	9.65
.007	0.18	.480	12.19
.010	0.25	.580	14.73
.100	2.54	4.900	124.46
.150	3.81	5.200	132.08

NOTES:

1. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
2. Datum plane E is established by the two keying pin features at their virtual condition.
3. Dimensions are in inches.
4. Metric equivalents are given for general information only.

FIGURE 28. Connector pin assignments - Continued.

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NOTES:

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

FIGURE 29. Module marking areas.

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APPENDIX D

DESIGN REQUIREMENTS FOR FORMAT D MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the design requirements for format D modules to be used in the Standard Electronic Modules Program (SEMP).

20. REFERENCED DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified.

SPECIFICATIONS

MILITARY

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

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

(Copies of the specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

30. GENERAL REQUIREMENT

30.1 Mechanical configuration requirements. The basic mechanical configurations are specified on figures 30 and 31 with incremental growth in thickness specified in table IX.

30.1.1 Lateral displacement. The module may be designed to provide a lateral displacement between the module frame and connector of $\pm .006$ inch (0.15 mm) minimum from center of the two guide rib profiles. The maximum force required to displace the connector shall be 5 pounds (22.2 newtons). 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 guide rib locational tolerance from datum D is not applicable if this option is exercised.

30.2 Thermal requirements. All modules shall be designed to be cooled through the ribs and shall be capable of being cooled by the rib with no other heat loss. Modules less than E thickness 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 .25 pound mass per minute (0.002 kilogram per second) for the A incremental thickness when tested in a duct size of 5.43 inches (137.9 mm) high and .315 inch (8.00 mm) wide. A maximum airflow rate of .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 (137.9 mm) high and .415 inch (10.54 mm) wide. Duct width shall be increased by .100 inch (2.54 mm) for each additional module thickness increment. For direct air impingement cooling, the maximum allowable static pressure loss shall be .30 inch (7.6 mm) of water.

40. DETAIL REQUIREMENTS

40.1 Configuration. The basic size module has a span of 5.88 inches (149.4 mm) maximum, a thickness of .280 inch (7.11 mm) maximum and is 4.83 inches (122.7 mm) maximum in total height. Module may increase in thickness in accordance with table IX. Dimensions and tolerances shall be as specified on figure 31.

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APPENDIX D

40.1.1 Circuitry. The module shall have a minimum clearance of .015 inch (0.38 mm) around all edges of the substrate or printed-wiring board. The printed-wiring board shall be further reduced to allow for insertion of the module extractor and 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 insertions.
- c. Component protection.
- d. Test point access.

40.1.2.1 Module identification. The module identification header shall have the configuration and marking as specified on figure 33.

40.1.2.2 Module insertion. The header structure shall be capable of withstanding 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.

40.1.2.4 Test point access. The module header shall provide readily accessible test points, however, all final electrical acceptable testing shall be performed through the (input/output) connector pins on the module. All individual modules shall be designed such that the removal of the header shall in no way effect the proper functioning of the module.

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 a minimum of two ribs: One located at the alpha end and one located at the beta end of the module. Modules of .6 inch (15 mm) pitch may have additional ribs in their thickness increments. The ribs, if present, shall be located on .300 inch (7.62 mm) centers from the basic rib location as shown on figure 31.

40.1.3.2 Module extractor interface. Modules shall have two extractor holes located as shown on figure 31. Modules having a thickness of 2.090 inches (53.09 mm) or greater shall have two sets of extractor holes. The second set shall be located within the last .3 inch (8 mm) of the module and meet the location requirements shown on figure 31.

40.1.4 Module connector. The basic module connector shall have two rows of 50 metal bayonet type contact pins. Modules of .4, .5, and .6 inch (10, 13, and 15 mm) pitch may increase contact pin quantity to three, four, and five rows of 50 contact pins with all rows of 50 pins to be complete.

40.1.4.1 Connector location. The location of connectors shall be as shown on figure 31. Each connector shall have contacts identified by numbers indicating the first and last pin of the row closest to the pin shield as shown on figure 32.

40.1.4.2 Contact pin location. The location of contact pins shall be as shown on figure 32.

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 this standard.

40.1.5 Module mechanical requirements. The following mechanical requirements apply.

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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. The module shall be capable of withstanding 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 header in a direction perpendicular to the plane of the header without detrimental effect to the mechanical or electrical properties of the module. During the time the torque is applied, the module shall be rigidly supported within a zone between the interface plane and 0.5 inch (13 mm) above the interface plane.

40.1.5.3 Module cantilever load. The module shall be capable of withstanding a force of 2 pounds (9 newtons) applied perpendicular to the header 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 without detrimental effect to the header structure.

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

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 of the ribs shall be 25 microinch (0.00064 mm) or better.

40.1.6.2 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.

40.1.6.3 Aluminum frame plating. All 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.

40.2 Thermal requirements. The following thermal requirements apply.

40.2.1 Heat dissipation. Modules shall be designed to ensure that critical component temperatures 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. Detail specifications covering any 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.

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40.2.3 Component temperatures. The following requirements for critical component temperature (CCT) and transient critical component temperature (TCCT) apply.

40.2.3.1 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/watt or a maximum of 15°C above that specified for less than 2.5 watt 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.

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

TABLE IX. Module growth. 4/ 5/

Thickness	A	B	C	D 1/	E
Module pitch 2/	.3 (8 mm)	.4 (10 mm)	.5 (13 mm)	.6 (15 mm)	.9 (23 mm)
Maximum module thickness	.280 (7.11 mm)	.380 (9.65 mm)	.480 (12.19 mm)	.580 (14.73 mm)	.880 (22.35 mm)
Maximum connector profile	.280 (7.11 mm)	.380 (9.65 mm)	.480 (12.19 mm)	.580 (14.73 mm)	.880 (22.35 mm)
Maximum number of pins	100	150	200	250	250
Dimension NN (max) 3/	.152 (3.86 mm)	.252 (6.40 mm)	.152 (3.86 mm)	.152 (3.86 mm)	.152 (3.86 mm)
Dimension YY (max) 3/	.152 (3.86 mm)	.152 (3.86 mm)	.352 (8.94 mm)	.452 (11.48 mm)	.752 (19.10 mm)

1/ The .6 inch (15 mm) pitch module configuration can increase in thickness in .3 inch (8 mm) increments with no increase in contact pin count.

2/ Pitch refers to the distance between module centerlines for system packaging purposes.

3/ The dimensions are from the center of the two basic guide rib profiles to locate connector lateral extreme displacement.

4/ Dimensions are in inches.

5/ Metric equivalents are given for general information only.

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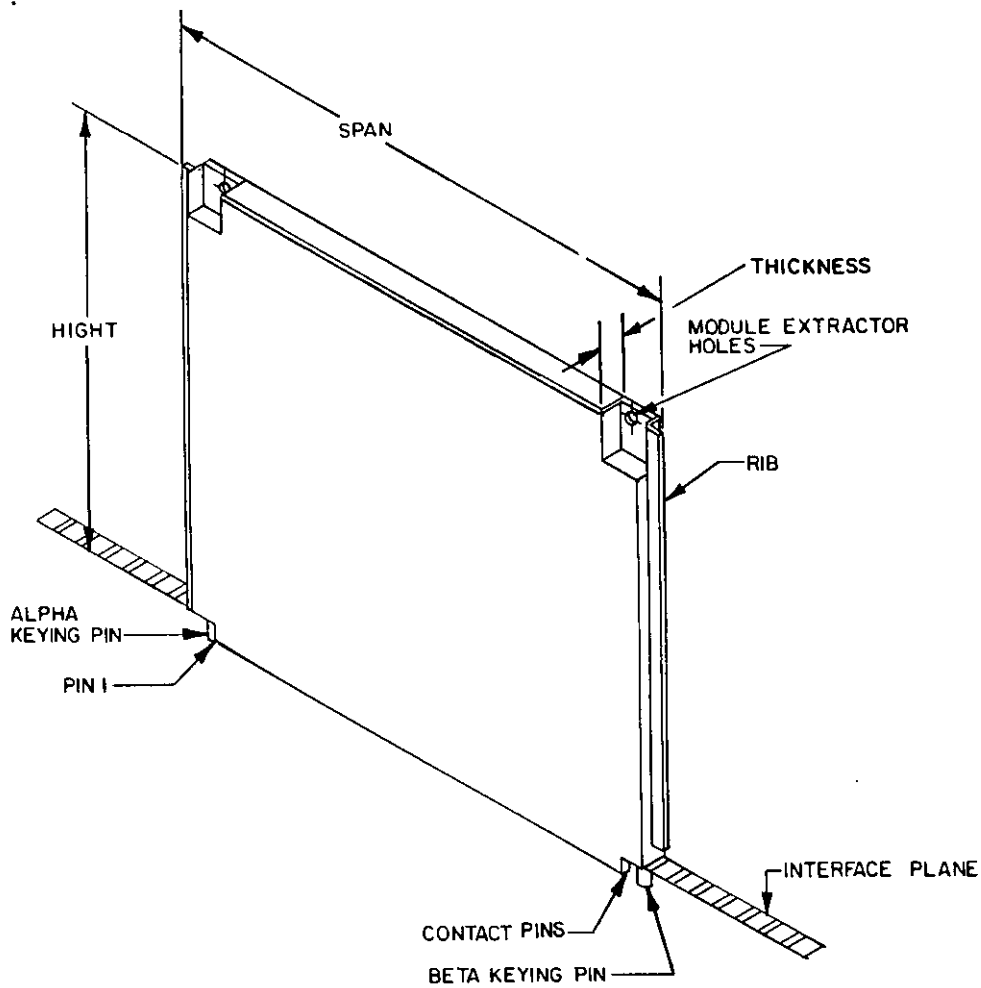
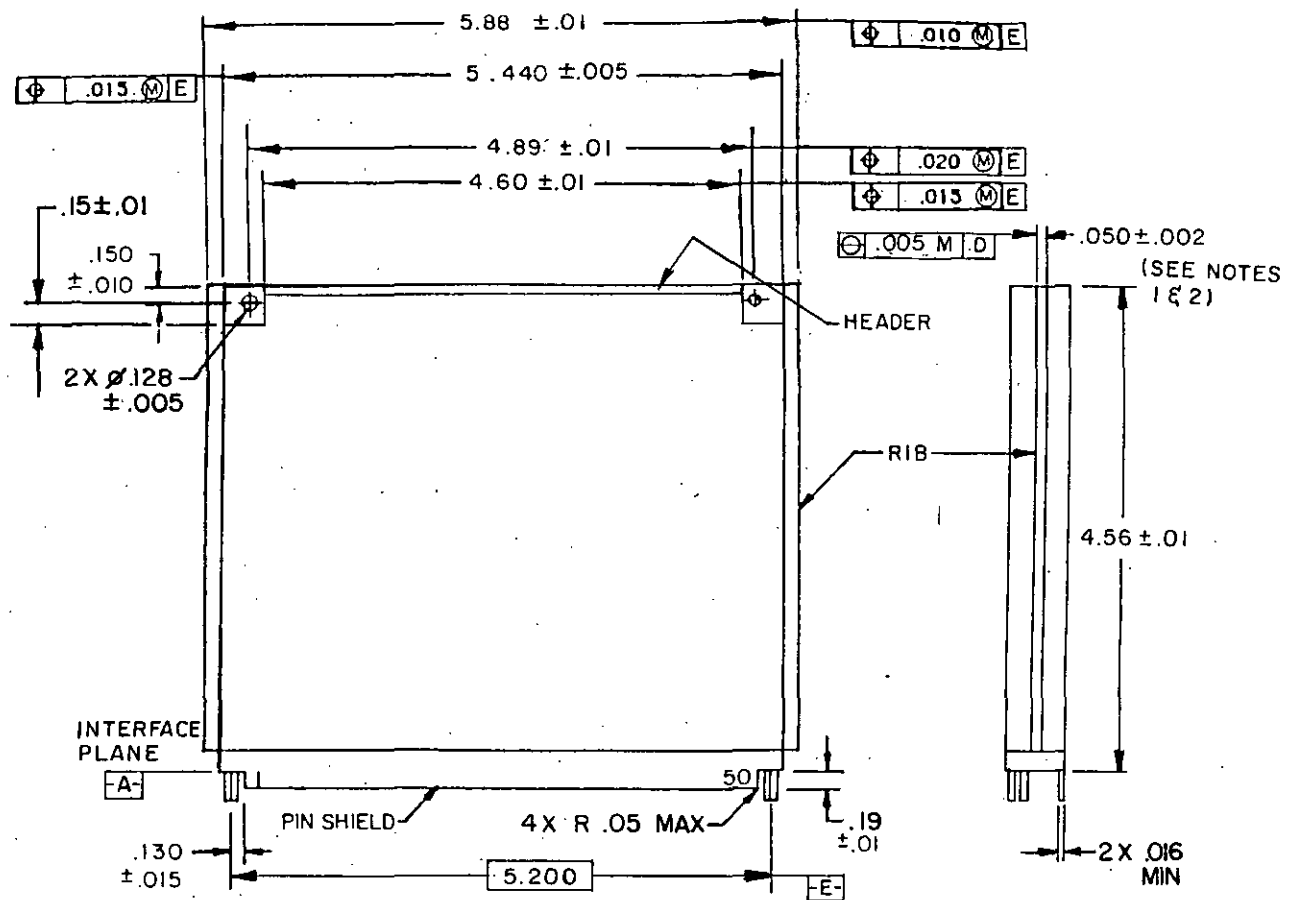


FIGURE 30. Module outline.

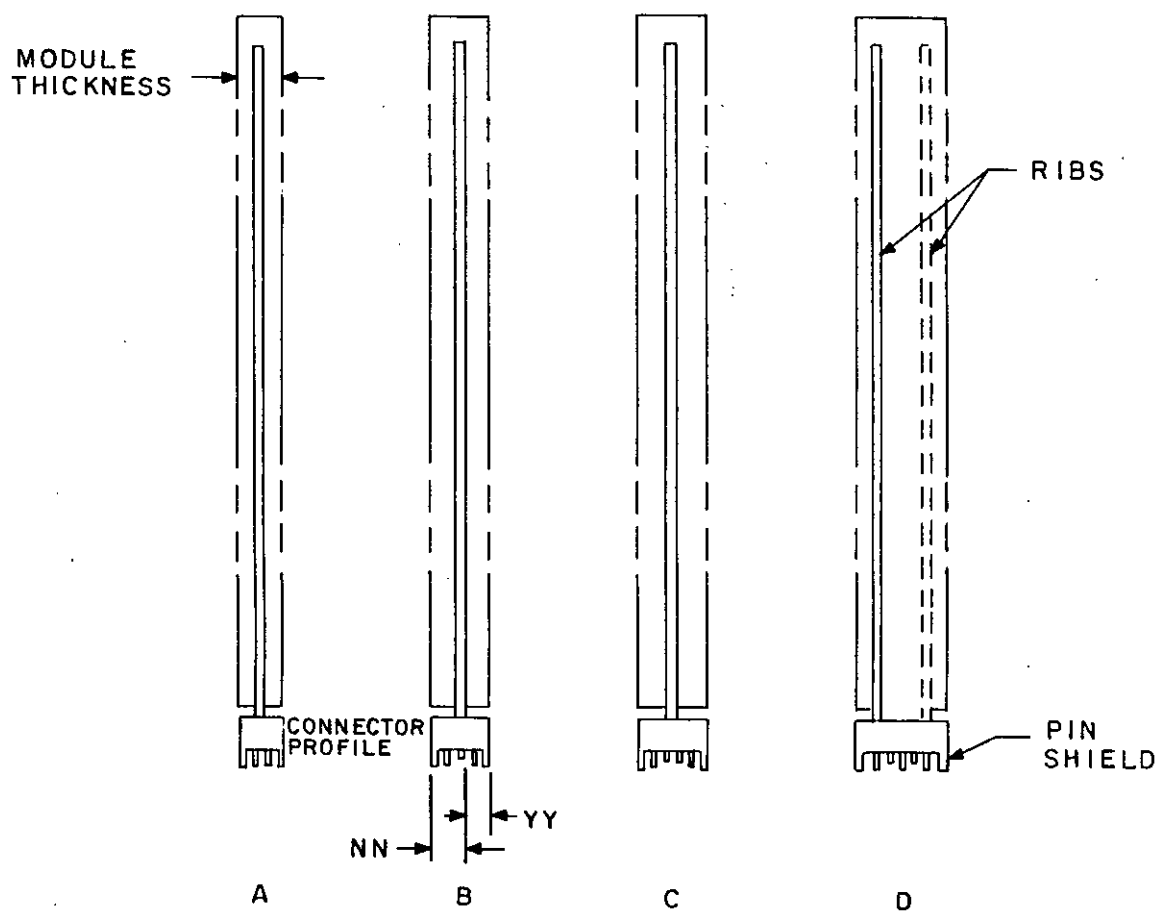
MIL-STD-1389C
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Inches	mm	Inches	mm	Inches	mm
.002	0.05	.050	1.27	4.56	115.8
.005	0.13	.05	1.3	4.60	116.8
.010	0.25	.128	3.25	4.89	124.2
.01	0.3	.130	3.30	5.200	132.59
.015	0.38	.150	3.81	5.440	138.18
.016	0.41	.15	3.8	5.88	149.4
.020	0.51	.19	4.8		

NOTES:

1. Rib feature shall be contained within .055 inch (1.40 mm) maximum zone.
2. Rib surface finish of 25 microinch (0.00064 mm) or better.
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.

FIGURE 31. Module configurations.

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APPENDIX DFIGURE 31. Module configurations - Continued.

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APPENDIX D

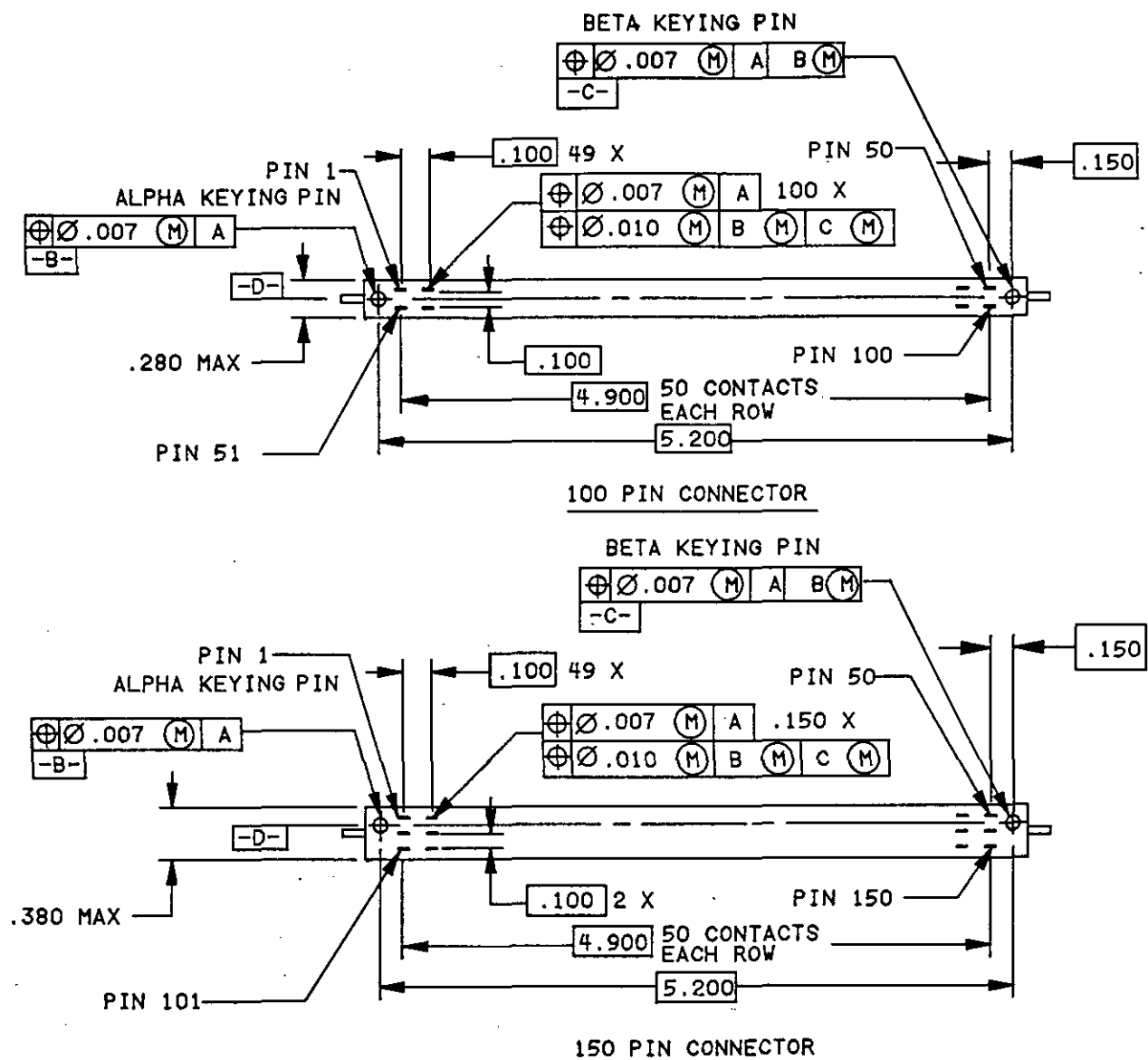


FIGURE 32. Connector pin assignments.

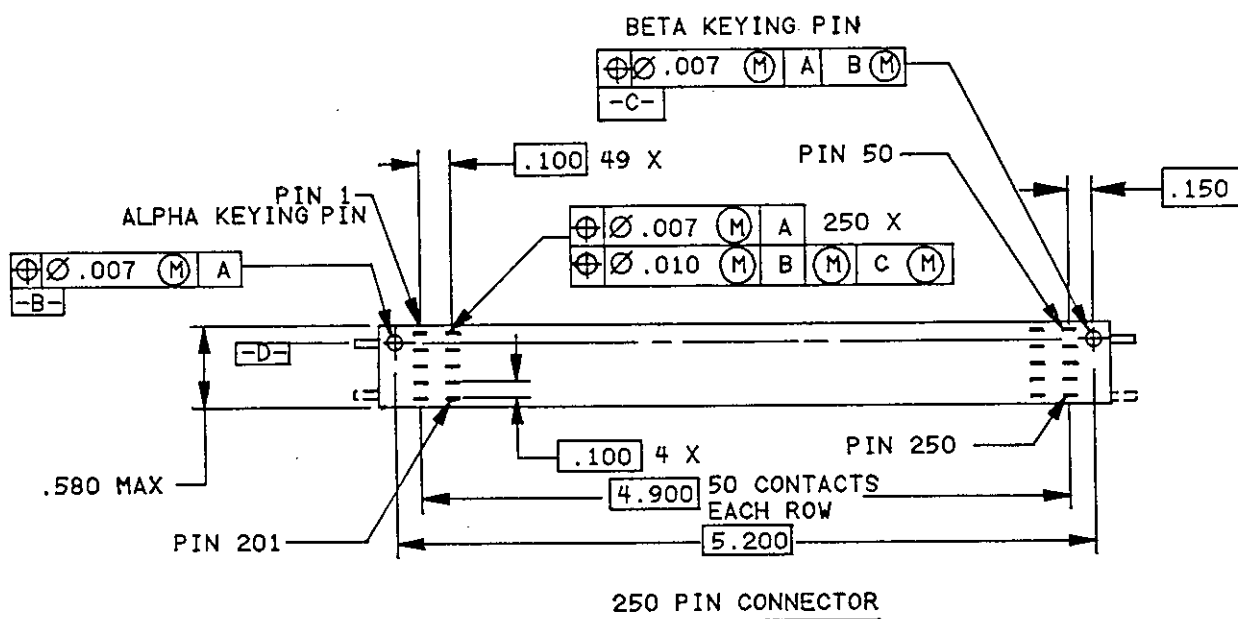
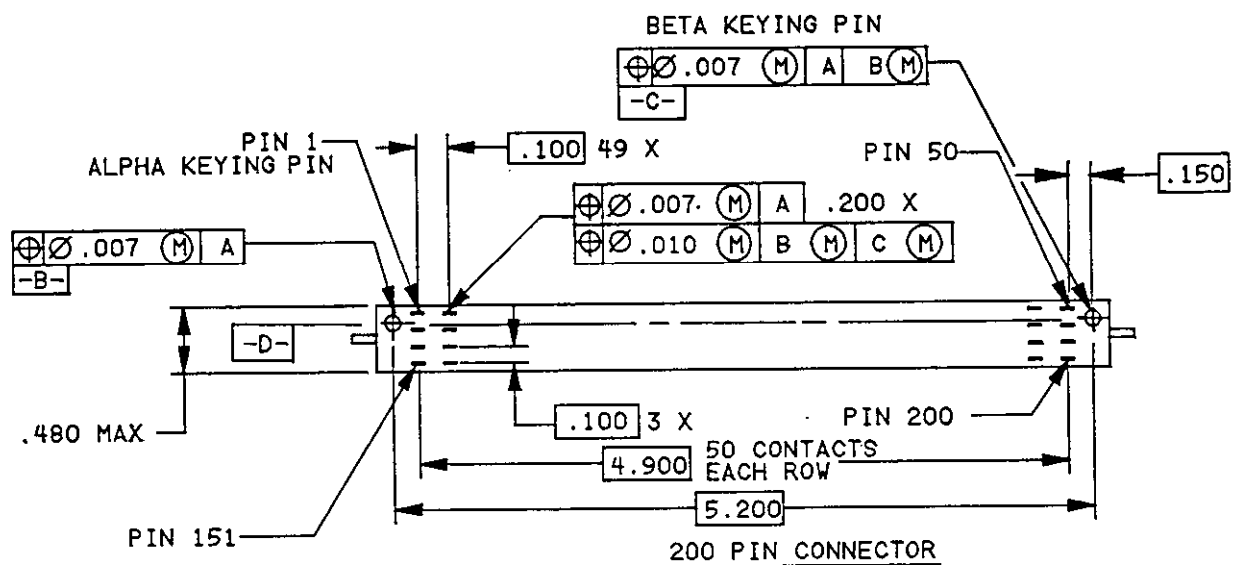
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FIGURE 32. Connector pin assignments - Continued.

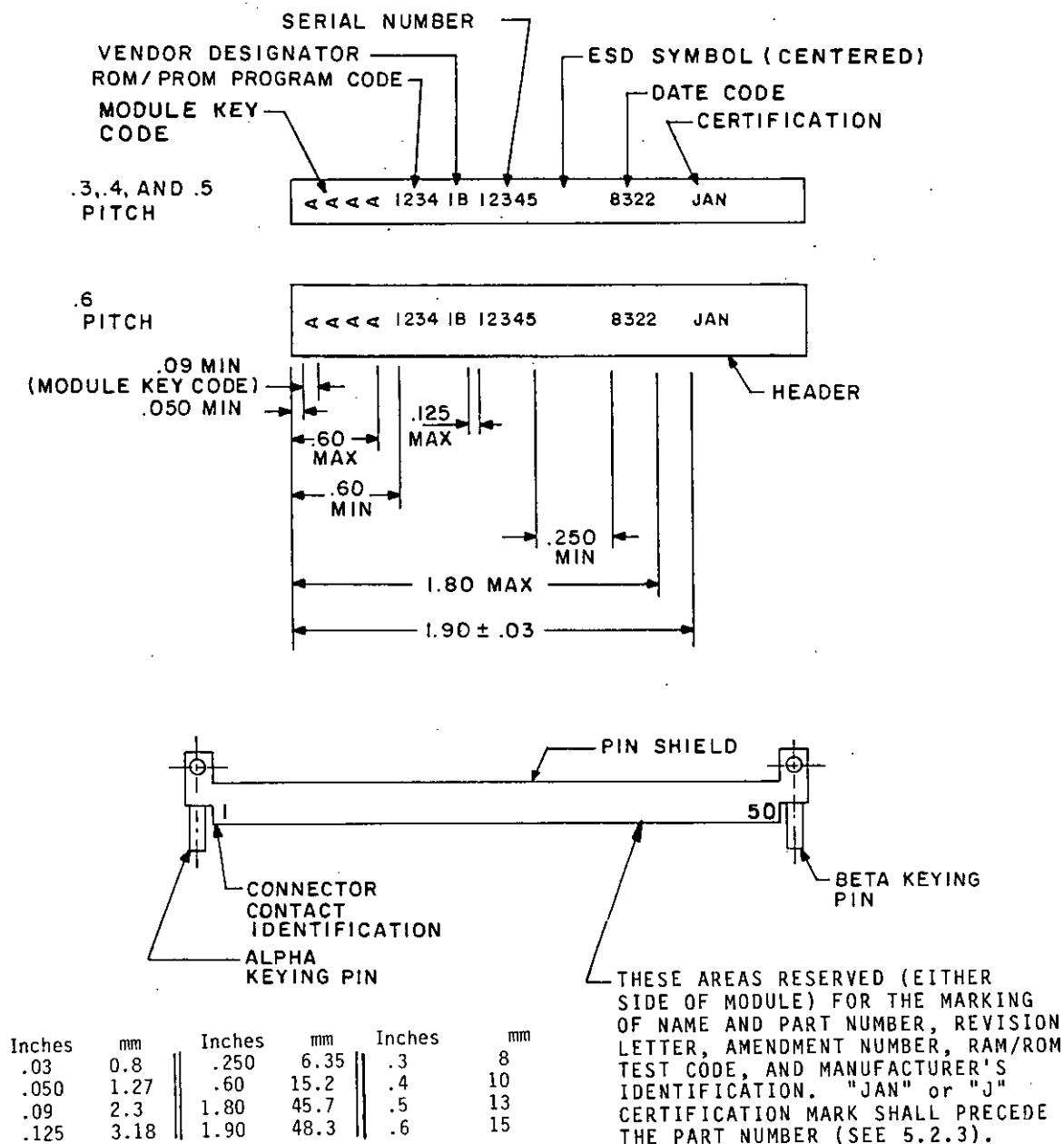
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Inches	mm	Inches	mm
.007	0.18	.480	12.19
.010	0.25	.580	14.73
.100	2.54	4.900	124.46
.280	7.11	5.200	132.08
.380	9.65		

NOTES:

1. Datum plane D is established as a plane passing through the center of both keying pin features at their virtual condition.
2. Datum plane E is established by the two keying pin features at their virtual condition.
3. Dimensions are in inches.
4. Metric equivalents are given for general information only.

FIGURE 32. Connector pin assignments - Continued.

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APPENDIX D

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

FIGURE 33. Module marking areas.

MIL-STD-1389C
APPENDIX EFAILURE RATE PREDICTION FOR
STANDARD ELECTRONIC MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the requirements and procedures for the prediction of the failure rate of Standard Electronic Modules (SEM).

20. REFERENCED DOCUMENT

20.1 Government document. The following document forms a part of this appendix to the extent specified:

HANDBOOK

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.

(Copies of the handbook required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

30. GENERAL REQUIREMENTS

30.1 General. The Standard Electronic Modules Program (SEMP) has adopted the MIL-HDBK-217 "Part Stress Analysis" method as a common basis for module failure rate predictions. The failure rate predictions shall be made with the following common MIL-HDBK-217 model data:

Environment = 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.)

Ambient temperature = Maximum class temperature (the temperature rise used in the piece part models shall be the temperatures submitted in the thermal analysis required by MIL-M-28787).

30.2 Piece part information. The following information shall be submitted for each piece part in the module failure rate prediction:

Part description.

Detail specification part number.

Schematic designator.

Part quantity.

MIL-HDBK-217 model used.

All MIL-HDBK-217 model inputs (factors, stress ratios, temperature rise, and so forth).

All assumptions made to use the MIL-HDBK-217 models.

Derating criteria used.

Failure mode and mode percentage: State component failure mode and approximate percentages.

30.3 Data format. Hard copy of data shall be furnished in the format shown in section 60. Machine readable data may be furnished in lieu of hard copy. Contact the SEMP-QAA for format requirements.

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

30.5 Module changes. Any changes in the module which affect the failure rate prediction shall require a resubmission of the failure rate prediction to the SEMP-QAA.

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APPENDIX E

30.6 Piece part failure rates. The supplier shall submit detailed information on the failure rate derivation of any piece part included in the prediction which is not modeled in MIL-HDBK-217.

30.6.1 Multilayer boards. The supplier shall submit detailed information on the failure rate derivation of any printed-wiring board board/substrate which is not modeled in MIL-HDBK-217.

30.7 Failure rate prediction techniques. The "Part Stress Analysis" method of MIL-STD-217 is the authorized method for use by the Standard Electronics Module Program. Any deviation from MIL-HDBK-217 requires prior approval of the SEMP-QAA.

30.8 Application. SEM failure rate predictions for MIL-HDBK-217 environments other than ground benign and maximum class temperature may be obtained by contracting the SEMP-QAA.

40. FAILURE RATE PREDICTION PROCEDURES

40.1 Printed-wiring boards. Printed-wiring boards are usually custom made and are composed of thin patterns of electrical conductors on a supporting insulation sheet. Generally, circuit parts are mounted on the board and connected directly to the printed conductors. It has been determined that the board failure rate is a function of the number of solder connections of the connector (pins), 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 sections.

40.2 Module connector pins. Module connector pins failure rates shall be considered in SEM failure rate calculations.

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

40.4 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 worksheet. Be sure that all 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. 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 and where higher stresses may contribute significantly to the failure rate, even if only for short periods of time, they should be used. 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 judgment must be exercised and each case analyzed separately.
- d. Refer to the proper 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.

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APPENDIX E

50. FAILURE RATE PREDICTIONS

50.1 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-wiring board and connection failure rates.
- c. Add the failure rates in a and b to derive the total module failure rate.

50.2 Assumptions made in calculation of failure rates. State all assumptions made to predict the failure rates.

50.3 Basis for failure rate prediction. This failure rate prediction shall reflect:

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

60. SAMPLE OF FAILURE RATE PREDICTION

60.1 Introduction. This section presents a sample module failure rate calculation to illustrate format and reference requirements.

60.2 General requirements. The module failure rate prediction shall include but is not limited to:

- a. All supporting references needed to substantiate the prediction.
- b. Module prediction cover sheet.
- c. Module summary sheet.
- d. Piece part work sheet(s).
- e. All MIL-HDBK-217 model input data.

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

60.2.2 Module prediction cover sheet. The module prediction cover sheet shall include military part number, the module key code, the date the module prediction was submitted, the name of the module designer (manufacturer), MIL-HDBK-217 revision letter, and the company contact point and telephone number.

60.2.3 Module summary sheet. The module summary sheet shall include the name of the individual piece parts (components), the quantity in the module (n), the individual piece part failure rate (λ), the two composite piece part failure rate ($n\lambda$), 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 following format.

60.2.4 Piece part work sheet(s). The piece part work sheet(s) for the individual components shall follow the module summary sheet in the same order as they appear in the module summary. 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/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 following format.

MIL-STD-1389C
APPENDIX ESample module summary sheet.

Component	η	λ	$\eta\lambda$	Schematic reference
Hybrid microcircuit, driver	2	0.36961	0.73922	U1, U2
Solid tantalum capacitor, MIL-C-39003	4	0.00028	0.00112	C1, C2, C3, C4
Fixed composition resistor, MIL-R-39008	2	0.00012	0.00024	R1, R2
Solder connections, connector (pins)	40	0.00011	0.0044	
Solder connections, plated through holes	0	0.0003	0	
Solder connections, piece parts	60	0.00023	0.0138	
Total	---	---	0.75878	---

Module failure rate = 0.75878 failures / 10^6 hours.

MIL-STD-1389C
APPENDIX ESample piece part work sheet.

Component: Hybrid microcircuit, driver.

Math model: $\lambda_P = \left(\sum C_C \lambda_C \Pi_G + \left[N_R \lambda_R + \sum N_I \lambda_I + \lambda_S \right] \Pi_F \Pi_E \right) \Pi_Q \Pi_D$

Reference: MIL-HDBK-217, revision D.

λ / Π	Assumptions/references
$\Pi_Q \Pi_L (C_I \Pi_T \Pi_V + C_2 \Pi_E) \Pi_G =$ $(1.0)(1.0) [(.012)(6.1)(1.0)$ $+ (.003)(.38)] (1) =$ $.07434$	(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 .
$\Pi_Q \Pi_L (C_I \Pi_T \Pi_V + C_2 \Pi_E) \Pi_G =$ $(1.0)(1.0) [(.018)(8.7)(1.0) +$ $(.0043)(.38)] (1) =$ $.15823$	(1) μ A741 die, 23 transistors. (2) Acquired to MIL-M-38510, class B. (3) Junction temperature = 89°C from thermal analysis. (4) Environment = G_B .
$\lambda_b (\Pi_E \Pi_A \Pi_Q \Pi_R \Pi_{S2} \Pi_C) \Pi_G =$ $.0029 [(1.0)(1.5)(.12)(1.0)(.88)(1.0)] .4 =$ $.00018$	(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.
$\lambda_b (\Pi_E \Pi_A \Pi_Q \Pi_R \Pi_{S2} \Pi_C) \Pi_G =$ $.0049 [(1.0)(1.5)(.12)(1.0)(.88)(1.0)$ $(.88)(1.0)] .4 =$ $.00027$	(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.
$\lambda_b (\Pi_E \Pi_Q \Pi_R \Pi_A \Pi_{S2} \Pi_C) \Pi_G =$ $.0019 [(1.0)(.15)(1.0)(1.0)(.7)(1.0)] .2 =$ $.00004$	(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.

MIL-STD-1389C
APPENDIX ESample piece part work sheet - Continued.

λ / Π	Assumptions/references
$\lambda_b (\Pi_E \Pi_Q \Pi_{CV}) \Pi_G =$ $.0063 [(1.0)(.3)(.9)] .8 =$ $.00136.$	(1) Ceramic chip capacitor (2 each). (2) CKR05. (3) 60% stress ratio. (4) 1 000 μ F. (5) Failure rate level P.
$\lambda_R = .00015$	(1) Thick film resistors (17 each). (2) Hybrid package temperature = 65°C.
$\lambda_I = .00130$	(1) Au - Al Interconnections (34 each). (2) Package temperature = 65°C.
$\lambda_I = .00087$	(1) Solder interconnections (34 each). (2) Package temperature = 65°C.
$\lambda_S = .108$	(1) Seal perimeter = 4.2 inches. (2) Package temperature = 65°C.
$\Pi_F = 1.25$	(1) Linear application.
$\Pi_E = .20$	(1) Environment = G _B .
$\Pi_Q = 1.0$	(1) Acquired to MIL-M-38510, class B.
$\Pi_D = 1.34$	(1) 38 interconnections. (2) .75 x .75 inch substrate. (3) Density = $38 / (.563 + .10) = 57.3$.

$$\lambda_p = (.07434 + .15823 + 2(.00018) + 2(.00027) + 2(.00004) + 2(.00136) + [17(.00015) + 34(.00130) + 4(.00087) + .108] (1.25)(.20)) (1.0)(1.34) =$$

$$(.23627 + (.15823) (.25)) (1.34) = .36961 \text{ failures}/10^6 \text{ hours}$$

MIL-STD-1389C
APPENDIX ESample piece part work sheet.

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, revision D.

λ/Π	Assumptions/references
$\lambda_b = .028$	(1) Stress ratio = applied voltage/rated voltage = $40/75 = .53$. (2) Temperature = 75°C (from thermal analysis). (3) Interpolate for 75°C and .53 stress ratio.
$\Pi_E = 1.0$	(1) Environment = Gp.
$\Pi_{SR} = .1$	(1) Ohms = 80. (2) Applied voltage = 40. (3) Ohms/applied voltage = 2.
$\Pi_Q = .1$	(1) Failure rate level R.
$\Pi_{CV} = 1.0$	(1) Capacitance = $1.1 \mu\text{F}$.

$$\lambda_P = .028 [(1.0)(.1)(.1)] = .00028 \text{ failures}/10^6 \text{ hours.}$$

MIL-STD-1389C
APPENDIX ESample piece part work sheet.

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

Math model: $\lambda_p = \lambda_b (\pi_E \pi_R \pi_Q)$.

Reference: MIL-HDBK-217, revision D.

$\lambda /$	Assumptions/references
$\lambda_b = .0012$	(1) Rated at .5 watts. (2) .2 watts applied. (3) Stress ratio = power applied/rated power = .2/.5 = .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.
$Q = .1$	(1) Failure rate level R.

$$\lambda_p = .0012 [(1.0)(1.0)(.1)] = .00012 \text{ failures}/10^6 \text{ hours.}$$

MIL-STD-1389C
APPENDIX E

Sample piece part work sheet.

Solder connections, connector (pins).

40 pin connector (.00011) = .004 failures/ 10^6 hours.

Solder connections, plated through holes.

Module does not use plated through holes.

Solder connections, piece parts.

Two 24 pin IC's = 48.

Four 2 lead capacitors = 8.

Two 2 lead resistors = 4.

Total = 60.

Therefore, 60 (.00023) = .0138 failures 10^6 hours.

MIL-STD-1389C
APPENDIX FFABRICATION REQUIREMENTS FOR PRINTED-WIRING
ASSEMBLIES USED IN STANDARD ELECTRONIC MODULES

10. SCOPE

10.1 Scope. This appendix is a mandatory part of this standard for the design requirements for the fabrication of printed-wiring assemblies used in Standard Electronic Modules (SEM).

20. REFERENCED DOCUMENTS

20.1 Government documents. The following documents form a part of this appendix to the extent specified:

SPECIFICATIONS

FEDERAL

QQ-S-571 - Reliability Prediction of Electronic Equipment.

MILITARY

MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base).
MIL-P-28809 - Printed Wiring Assemblies.
MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies).

(Copies of the specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

20.2 Other publications. The following document forms a part of this appendix to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the issue of the DODISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DODISS.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

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

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

(Nongovernment standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

30. GENERAL REQUIREMENTS

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

30.2 Conflict. In event of any conflict between the requirements of this appendix and the documents referenced herein, the requirements of this appendix shall govern.

30.3 Terms and definitions. Terms and definitions shall be in accordance with ANSI/IPC-T-50.

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

30.4.1 Printed-wiring boards. Printed-wiring boards shall be in accordance with this standard.

30.4.2 Solder. The solder alloy shall conform to composition Sn60 or Sn63 of QQ-S-571.

MIL-STD-1389C
APPENDIX F

30.4.3 Flux. Flux shall conform to type R, RMA, or RA of MIL-F-14256.

30.4.4 Conformal coating. Conformal coating shall be in accordance with 40.14.

40. DETAIL REQUIREMENTS

40.1 Part attachment. Part attachment shall be made by passing the lead through a lead termination hole located in a terminal area (except when the method in 40.1.3 is used) and electrically connecting it by the use of solder to the terminal area on the side of the printed-wiring board opposite to where the parts are mounted. No more than one lead shall be inserted into any one hole. For multilayer printed-wiring boards, part attachment shall be through a plated through hole, except when 40.1.3 applies. Part attachment shall be made by one or several of the following methods.

40.1.1 Unclinch leads. When straight through leads are used in unsupported holes, the free ends of the leads shall extend a minimum of .015 inch (0.38 mm) beyond the board surface and shall exhibit lead definition in the solder fillet (see figure 34). When straight through leads are used in plated through holes, the free ends of the leads shall have a minimum lead definition and a maximum of .060 inch (1.52 mm) extension on the soldered side of the printed-wiring board and shall not be recessed below the board termination pad. The leads may be swaged or otherwise formed for part retention prior to soldering or a holding device may be used to prevent movement of the part and leads during soldering.

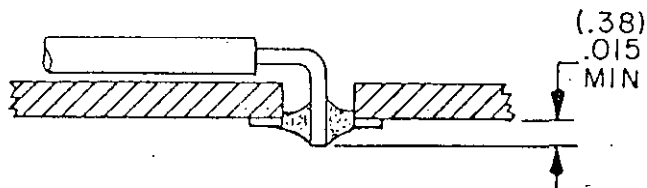


FIGURE 34. Leads in unsupported holes.

40.1.2 Clinched leads. If the lead is clinched, the lead shall make contact with the conductor pattern before soldering and the end shall not extend more than .030 inch (0.76 mm) beyond the edge of the terminal area or its electrically connected conductive pattern and the electrical clearance shall be maintained as specified in MIL-STD-275. The outline of the free end of the lead shall be visible in the solder fillet; however, the solder shown in the hole is not intended to indicate a quantitative solder requirement.

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APPENDIX F

40.1.3 Planar leads. Wire leads may be attached to terminal areas on the part side of the printed-wiring board, provided the body is properly insulated from the terminal areas and conductors. The contact between any lead and terminal area shall be not less than .030 inch (0.76 mm) for soldered connections and .045 inch (1.14 mm) for welded connections. Round leads shall not be welded. Minimum printed conductor spacing shall be maintained. After lead attachment, the distance from the top of the lead to the top of the conductor shall be no greater than three times the lead thickness and the lead shall be visible (see figure 35).

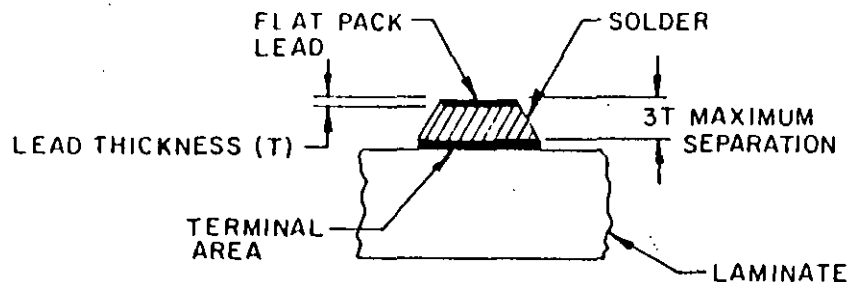


FIGURE 35. Flat lead termination.

40.2 Part mounting. Parts shall be mounted as follows.

40.2.1 Location. All parts shall be mounted so as not to obscure the terminations of another part. Whenever possible, parts shall be mounted to avoid the occurrence of moisture traps. Whenever possible, parts shall be mounted on only one side of the printed-wiring board. Parts shall be mounted so that no portion of the attached part extends beyond the edge of the printed-wiring board. Parts shall be mounted to withstand all the vibration, mechanical shock, and thermal requirements for the applicable module class. Parts shall not be located or placed across or on top of other parts, unless approved by the SEMP-QAA prior to initial qualification. Parts shall not affect interfacing with subsequent assemblies.

40.2.2 Metallic parts. Parts with conductive surfaces shall have precautions taken to ensure the conductive surfaces do not short out to other runs (that is, raise the part from the circuit board, insulate the part, or no conductor runs pass under the part).

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APPENDIX F

40.2.3 Heat dissipation part. All parts dissipating 1 watt or more shall be mounted so that the body of the part is not in direct contact with the printed-wiring board unless either a clamp or thermal ground plane, or both, is used which will dissipate sufficient heat so that the maximum allowance operating temperature of the printed-wiring board is not exceeded.

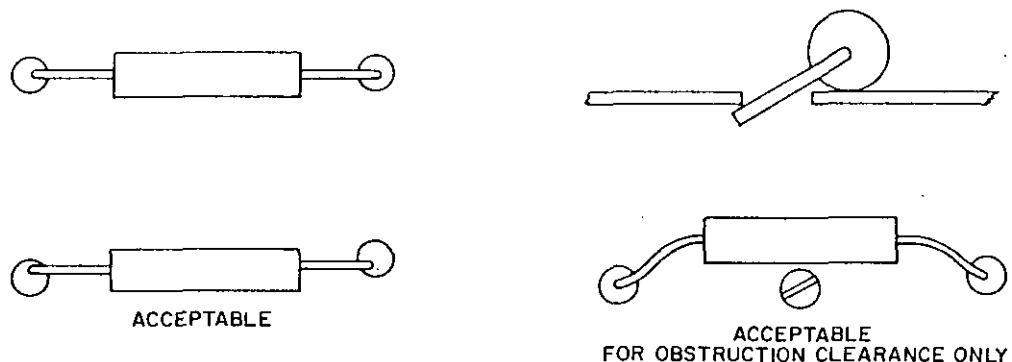
40.2.4 Axial lead parts. Axial lead parts weighing less than 0.25 ounce (7 grams) per lead, dissipating less than 1 watt, and not clamped or otherwise supported, shall be mounted so that a portion of body is as close to the printed-wiring board as practicable. Parts having two axial leads and weighing less than 0.50 ounce (14 grams) may be vertically (hair pin) mounted as specified herein provided the resulting mounting meets the shock and vibration requirements of the applicable module class.

40.2.5 Heavy parts. All parts weighing 0.25 ounce (7 grams) per lead or more shall be mounted by clamps or other means of support, such as embedment, which insure that the soldered joints are not relied upon for mechanical support or strength.

40.2.6 Alignment. Parts should be mounted with their major axis parallel to board edges or perpendicular to the board mounting surface. In addition, the parts should be mounted mutually parallel or perpendicular to provide an orderly appearance.

40.2.7 Axial lead parts mounting. Axial lead parts shall be mounted as follows.

40.2.7.1 Horizontal part mounting. Horizontal axial lead parts shall be mounted so that their axis is essentially parallel to the mounting base. Parts shall have the body in direct contact with a maximum of .030 inch (0.76 mm) gap with respect to the mounting base. When parts are raised from the mounting surface to prevent moisture traps, the .030 inch (0.76 mm) maximum dimension of the part from the mounting surface does not apply provided the printed-wiring board assembly meets the thermal, mechanical shock, and vibration requirements for the applicable module class. Part leads shall be routed such that they are approximately parallel to the board surface and shall enter the lead mounting hole approximately perpendicular to the board. Parts shall be located in line with the terminating holes of the respective part. The amount of misalignment permitted is that misalignment caused by the difference in diameters of the hole and the part lead or when essential for routing around obstructions (see figure 36). The location of the lead bend shall be such that the lead extends approximately straight from the body of the part a minimum of .015 inch (0.38 mm) prior to the start of any bend or twist. The end of the body is defined to include any part coating meniscus, solder seal, solder or weld bead, or any other extension. The minimum inside bending radius of the part lead shall be one lead diameter. Where space permits, the inside bending radius should be equal to or greater than twice the lead diameter (see figure 37). If the location of the mounting holes is such that the standard right angle bend cannot be used, a loop bend as shown on figure 38 may be used provided proper electrical clearances are maintained.



NOTE: No attempts shall be made to straighten or realign the parts after the part leads have been soldered.

FIGURE 36. Part alignment.

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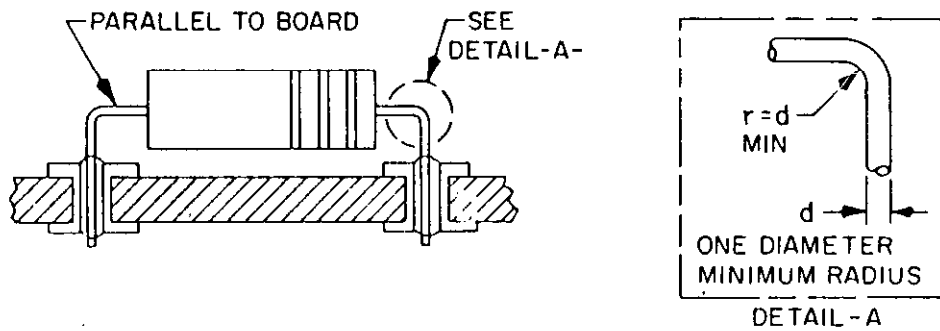


FIGURE 37. Radius of lead bend.

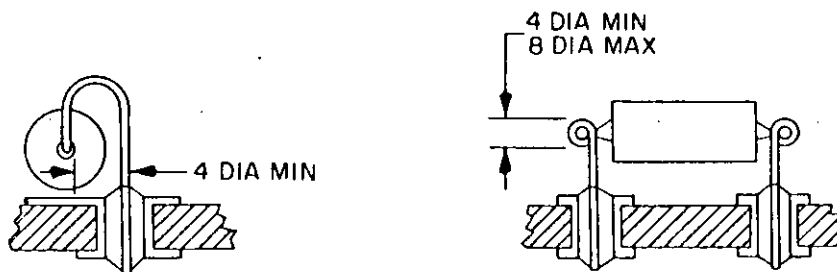


FIGURE 38. Loop bend.

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APPENDIX F

40.2.7.2 Vertical part mounting. Axial lead parts mounted with the major axis perpendicular to the mounting surface shall be installed to provide a minimum of .010 inch (0.25 mm) and a maximum of .060 inch (1.52 mm) between the end of the part body and the mounting surface. The end of the part is defined to include any coating meniscus, solder seal, solder or weld bead, or any other extension. Glass beads may be used to provide the necessary spacing. The maximum vertical misalignment of the parts vertical axis shall be 15 degrees in any direction from a line perpendicular to the mounting surface. Part leads shall be routed such that they enter the lead mounting hole approximately perpendicular to the board surface. The location of the lead bend shall be such that the lead extends approximately straight from the body of the part a minimum of .015 inch (0.38 mm) prior to the start of any bend or twist. The minimum inside bending radius of the part lead shall be two lead diameters (see figure 39). The maximum allowed vertical height from the board mounting surface shall be .55 inch (13.97 mm).

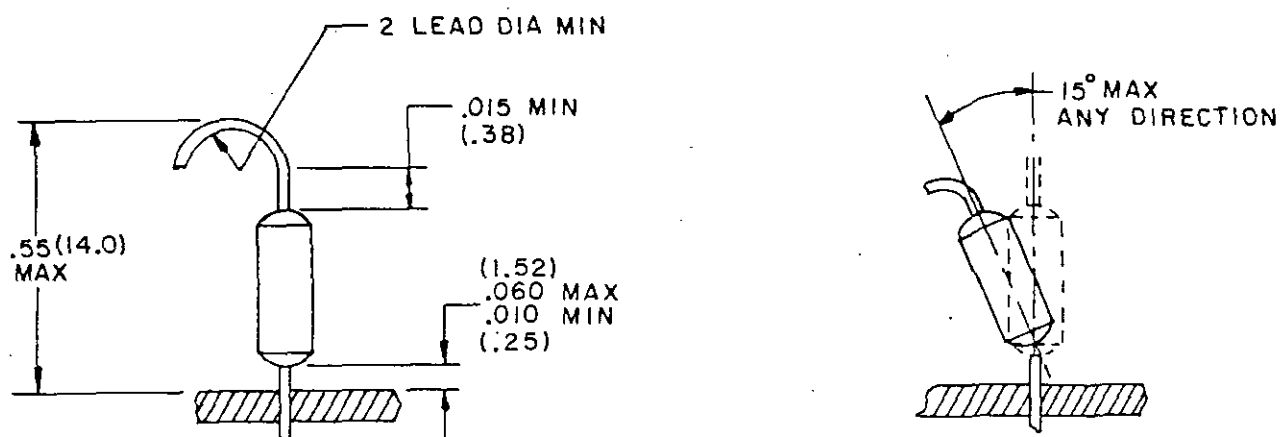


FIGURE 39. Vertical part mounting.

40.2.8 Radial lead parts. Radial lead parts have leads exiting from a common side of the part. Typical radial lead parts include molded or dipped capacitors and transistor cans.

40.2.8.1 Molded and dipped part mounting. Molded and dipped parts shall be mounted so that their axes are essentially parallel or perpendicular to the mounting surface (see figure 40). Parts shall have their vertical axis aligned within 15 degrees of a line parallel or perpendicular to the mounting surface. On coated or sealed parts, the coating on the leads shall not be removed beyond where the lead enters the part body. In addition, parts shall be mounted so that the coating does not enter the mounting hole (see figure 41).

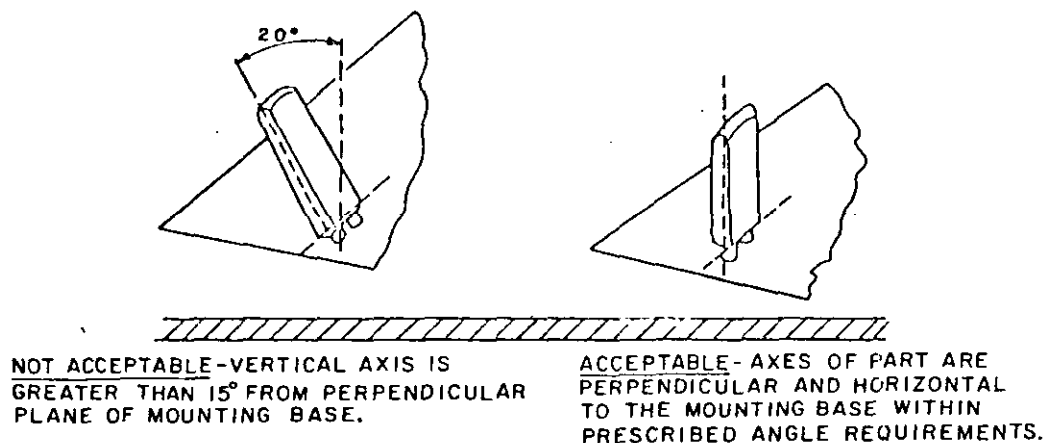
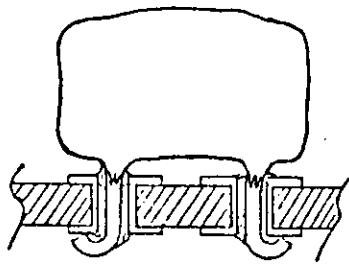
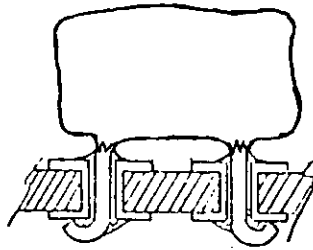


FIGURE 40. Molded radial lead part mounting.

MIL-STD-1389C
APPENDIX FNOT ACCEPTABLE

COATING ON LEAD EXTENDS
INTO SUPPORTED HOLE.

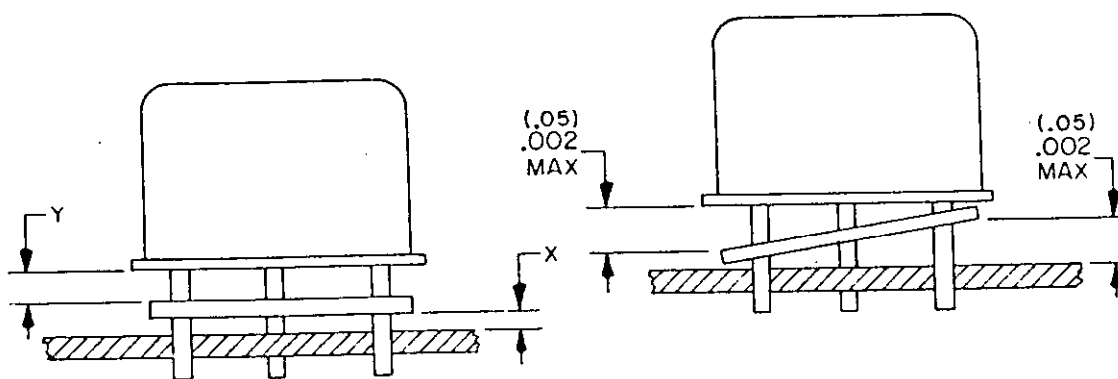
ACCEPTABLE

COATING ON LEADS DOES NOT
EXTEND INTO SUPPORTED HOLE.

FIGURE 41. Coated or sealed radial lead parts.

40.2.8.2 Transistor mounting. Transistors shall be mounted as follows.

40.2.8.2.1 Classes I and III modules. Transistors mounted on electrical insulators shall have a total cumulative separation of .030 inch (0.76 mm) between the transistor, insulator, and circuit board. That is, there may be .020 inch (0.51 mm) between the insulator and board in which case only .010 inch (0.25 mm) would be allowed between the transistor and insulator. The cumulative separation may be divided in any incremental combination as long as the .030 inch (0.76 mm) maximum tolerance is not exceeded (see figure 42). Transistors mounted on thermal conductors shall have a maximum space of .002 inch (0.05 mm) between the transistor and thermal conductor and between the thermal conductor and the circuit board. However, the transistor shall be in contact with the electrical insulator or thermal conductor and the electrical insulator or thermal conductor shall be in contact with the circuit board at some point. The .002 inch (0.05 mm) maximum separation is a nonaccumulative tolerance (see figure 42).



ELECTRICAL INSULATOR ONLY X PLUS Y
SHALL NOT EXCEED .030 INCH (0.76 mm)

FIGURE 42. Transistor mounting.

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APPENDIX F

40.2.8.2.2 Classes II and IV modules. Transistors mounted on electrical insulators or thermal conductors shall have a maximum space of .002 inch (0.05 mm) between the transistor and the electrical insulator or thermal conductor; and between the electrical insulator or thermal conductor and the circuit board. However, the transistor shall be in contact with the electrical insulator or thermal conductor and the electrical insulator shall be in contact with the circuit board at some point. The .002 inch (0.05 mm) maximum separation is a nonaccumulative tolerance (see figure 42).

40.2.9 Planar lead part mounting. Planar lead parts such as flat packs, hybrids, and so forth, shall conform to the following requirements. For part leads .005 inch (0.13 mm) and greater in width or thickness, the start of the bend of the leads shall be a minimum of .020 inch (0.51 mm) from the edge of the part body. For part leads less than .005 inch (0.13 mm) in width and thickness, there is no tolerance for bends (see figure 43). Part leads shall have a minimum of .030 inch (0.76 mm) for soldered type connections and a minimum of .045 inch (1.14 mm) for welded type connections in contact with the terminal land or pad (see figure 44). Part leads shall be axially parallel to land areas whenever possible. The part lead may overhang the land area a maximum of .005 inch (0.13 mm) for components and .030 inch (0.76 mm) for connectors on the length and .002 inch (0.05 mm) on the width, provided the minimum electrical spacing specified in MIL-STD-275 is maintained (see figures 45 and 46). Part leads shall be mounted with the terminating portion parallel within 15 degrees of the terminating land or pad as shown on figure 47.

40.2.9.1 Planar lead part mounting in plated through holes. When planar lead parts, such as flat packs, hybrids, are mounted in plated through holes solder wicking up the leads on the component side shall be controlled by the following criteria:

- a. A solder thickness of .005 inch (0.13 mm) is acceptable for the full length of the lead on the component side if the minimum lead height on the component is .015 inch (0.38 mm). A solder thickness of .010 inch (0.25 mm) is acceptable if the minimum lead height is .020 inch (0.51 mm). These values are based on a lead center-to-center distance of .450 inch (11.43 mm) or less.
- b. Solder wicking on only one side of the flat pack is acceptable regardless of the fillet size provided that all leads on the opposite side of the flat pack have a minimum solder free lead length of .015 inch (0.38 mm).

40.3 Electrical clearance. Uninsulated metal clad parts which are part of the electrical circuitry and part leads shall be a minimum of .015 inch (0.38 mm) from all conductive surfaces other than their termination (see figure 48). Insulation shall be applied to any uninsulated part or part lead if the design does not permit the .015 inch (0.38 mm) minimum spacing. Uninsulated leads, especially on vertical mounted axial lead parts, which if bent could contact other part leads or metal hardware, shall be insulated. Sleeving, booting, and conformal coating are acceptable forms of insulation. If conformal coating is used, the proper thickness shall be applied to ensure dielectric protection against maximum voltage potentials that will exist, but coating thickness on the board surface shall conform to the requirements of 40.14.

40.4 Soldered connections. Solder connections shall be in accordance with the following requirements.

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APPENDIX F

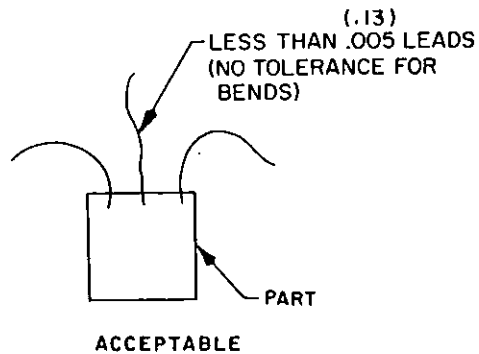
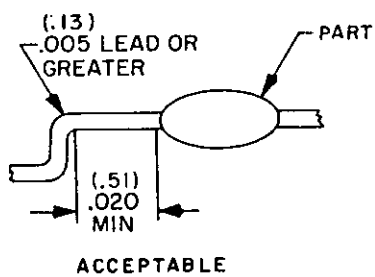
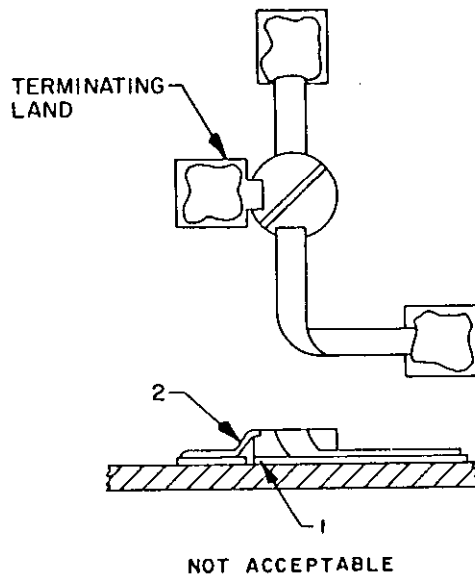
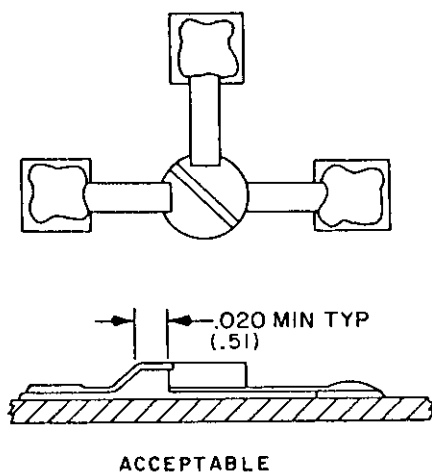


FIGURE 43. Bend restriction.

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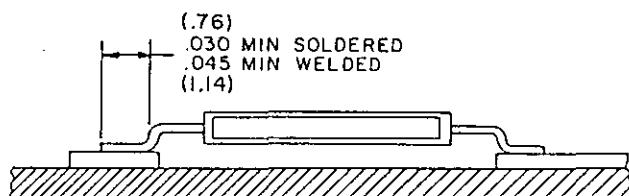
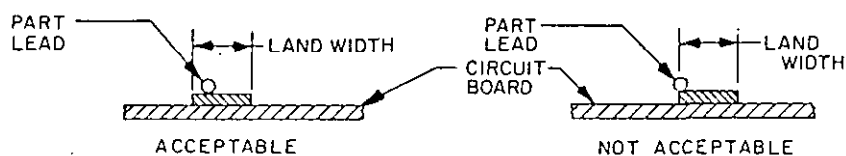
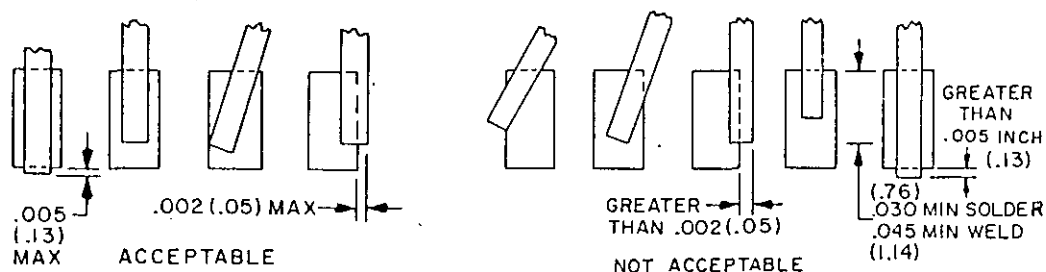


FIGURE 44. Minimum planar lead contact.

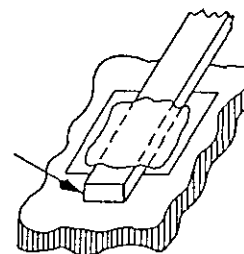


PART LEAD CENTERED OR
EDGE OF LEAD DOES NOT
OVERHANG LAND AREA BY
MORE THAN .002 INCH (.05 mm)
OR .030 INCH (0.76 mm)
(SEE 40.2.9)

EDGE OF LEAD OVERHANGS LAND AREA
BY MORE THAN .005 INCH (.13 mm)

FIGURE 45. Axial alignment.

LEAD EXTENDS BEYOND EDGE OF LAND
GREATER THAN .005 INCH (0.13 mm)
OR .030 INCH (0.76 mm) (SEE 40.2.9)



NOT ACCEPTABLE

FIGURE 46. Lead extension.

MIL-STD-1389C
APPENDIX F

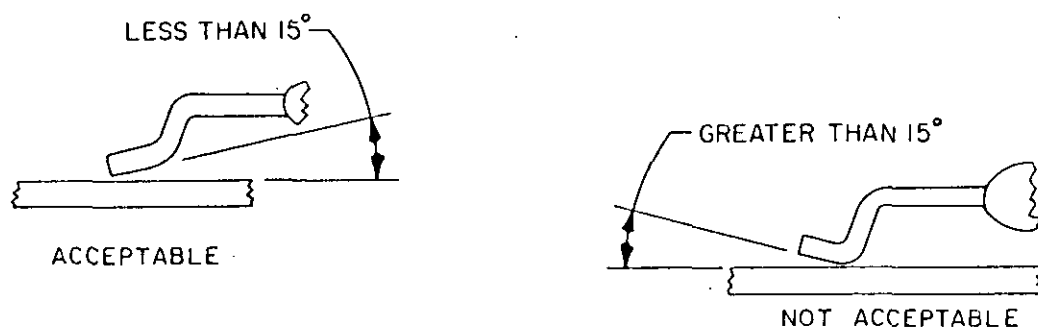


FIGURE 47. Formed lead alignment.

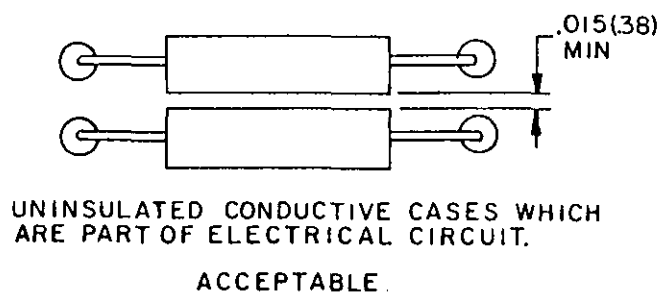
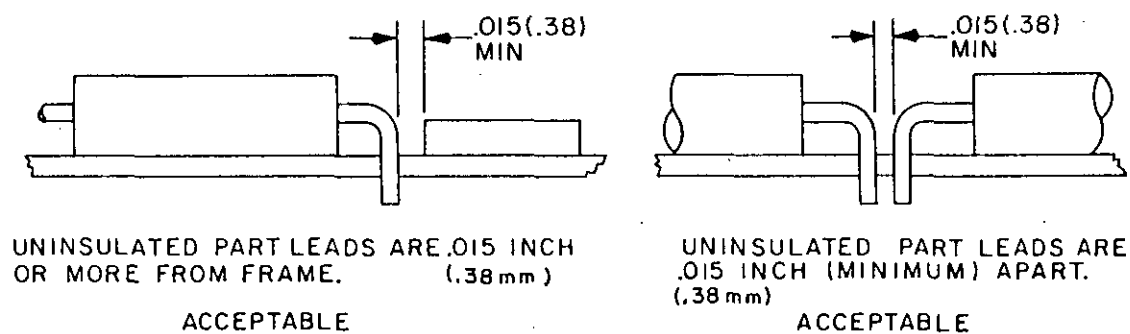


FIGURE 48. Electrical clearance.

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APPENDIX F

40.4.1 Solder finish. The finish of all solder connections except those which incorporate one or more gold or gold plated elements shall be lustrous and smooth without voids, cracks, gaps, blowholes, or other discontinuities. The connection must exhibit 100 percent wetting and show no indication of a cold or rosinous solder joint by the appearance of a dull grainy surface, balled solder, convex fillets, or excess rosin imbedded in the surface of the solder. No insulation material or other contaminants shall be included or imbedded in the solder. 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. A void or blowhole shall not be described as a small dent or impression mechanically made after the solder joint was made (that is, as a result of "probing" a solder joint to make electrical continuity during a troubleshooting operation) nor shall it be described as a slight pit in the solder joint where the bottom of the pit is visible. For special technologies, the visual inspection shall be performed at a minimum of ten power.

40.4.1.1 Method of soldering. Printed-wiring assemblies may be hand, wave, reflow, or dip soldered. Assemblies utilizing through hole attachment shall be hand soldered only when approval is obtained from the SEMP-QAA prior to initial qualification. The exceptions to this are the hand soldering of flat packs and module rework which shall not require prior approval.

40.4.2 Through hole attachment. Part leads on components such as DIP, axial leads soldered into plated-through holes shall have lead definition on the soldered side of the printed-wiring board. The plated through holes shall be at least three fourths full of solder and shall exhibit good wetting (see figure 49). If the part is .125 inch (3.18 mm) in diameter or less, or if the ratio of the body diameter to lead diameter is less than four, solder fillets shall be permissible in the lead bend radius. On larger parts a solder fillet in the lead bend shall be permissible on one end only. Part leads inserted into unsupported holes shall have lead definition on the soldered side of the printed-wiring board and the soldered connection shall exhibit good wetting to the solder lead and pad. The free end of the lead in an unsupported hole shall protrude a minimum of .015 inch (0.38 mm) beyond the board surface (see figure 34).

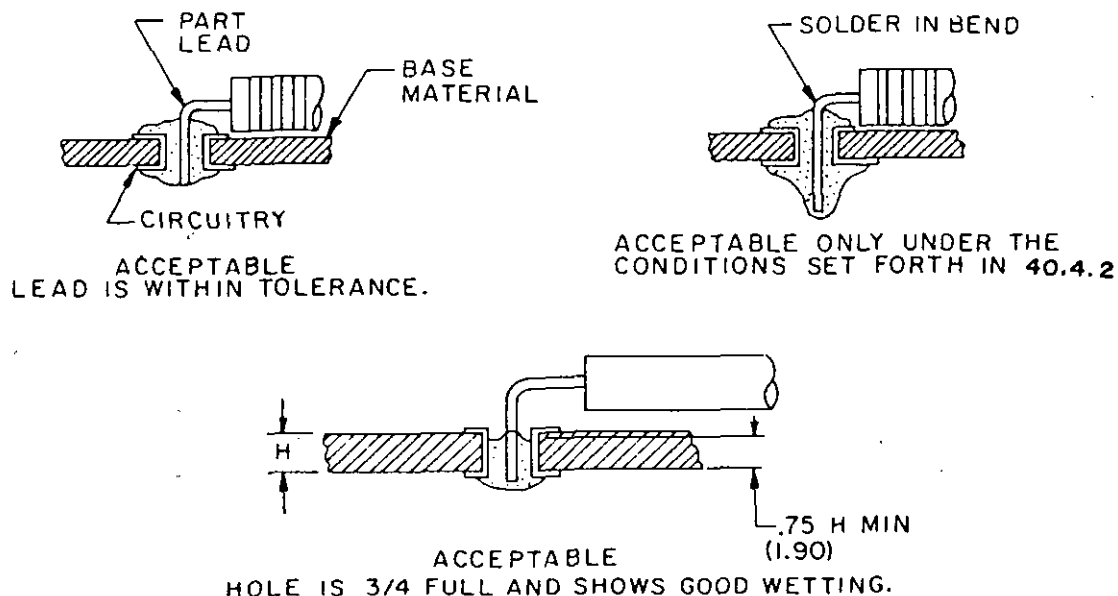


FIGURE 49. Leads in supported holes.

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40.4.3 Planar attachment. For planar attached leads, solder shall cover all elements of the lead/pad interface. The fillet shall be a minimum of 25 percent the diameter/height of both sides of that portion of the lead included in the connection and shall feather to the edge of the termination surface or land to which the lead is attached. The fillet shall be in accordance with the requirements shown on figure 50. The fillet shall be continuous along both sides of the lead. The contour of leads .005 inch (0.13 mm) thick and larger shall be discernible through the solder in a completed connection (see figure 51).

40.4.4 Solder projections. Solder projections within any soldered connection shall not be acceptable (see figure 52).

40.4.5 Interfacial connections. When printed-wiring assemblies are wave or dip soldered, 98 percent of the plated through holes (except those covered by a suitable solder mask) used as electrical interfacial connections shall contain solder plugs. Plated through holes shall be considered to contain an acceptable solder plug if, when the printed-wiring board assembly is backlighted, there is no evidence of light passing through plated through holes.

40.5 Welded connections. Welded connections shall not exhibit damage (that is, melting of the epoxy base laminate) caused by incorrect weld schedules. All 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-wiring assembly performance.

40.6 Jumper wires. The use of jumper wires shall not be allowed unless approved by the SEMP-QAA.

40.7 Solder coating and tin lead plating. When used, the solder coating and tin lead plating of part leads should be a minimum of .0003 inch (0.01 mm) thick and shall not exhibit pitting, pinholes, and so forth. Tin lead plating shall be 50 to 70 percent tin content. Solder coating shall be in accordance with Sn60 and Sn63 of QQ-S-571.

40.8 Repair and rework. The rework of defective solder connections and the replacement of defective parts shall be permissible providing the rework does not degrade the mechanical, electrical, or physical properties of the printed-wiring assembly. Repairs shall not be made to broken or otherwise damaged conductor paths on the printed-wiring board and assembly.

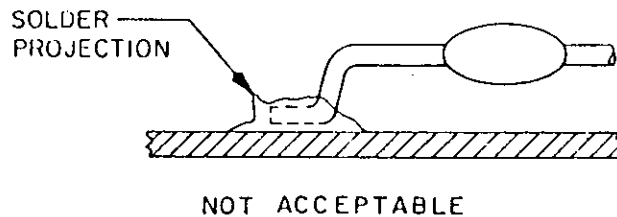


FIGURE 50. Solder projections.

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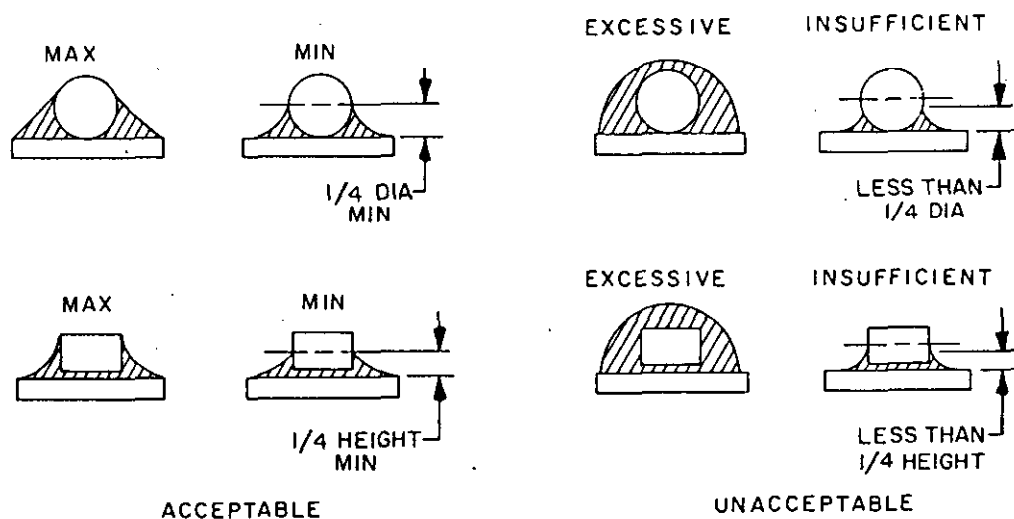


FIGURE 51. Solder coverage.

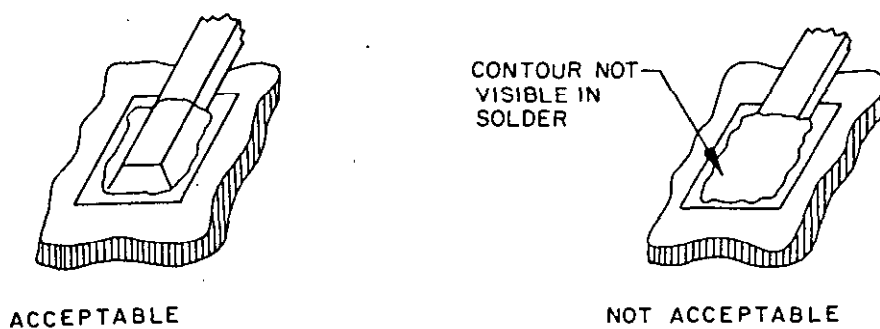


FIGURE 52. Lead contour.

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40.9 Cleanliness. The printed-wiring assembly shall be free of foreign materials such as dirt, chips, filings, stains, and conductive materials. There shall be no evidence of solder rosin or flux remaining on any part of the printed-wiring assembly. The printed-wiring assembly shall also be free from loose or splattered solder, corrosive materials, or any other material which may adversely affect the mechanical or electrical performance of the assembly. Cleaning processes used shall not degrade the electrical or mechanical properties of the printed-wiring assembly. After assembly of parts and prior to conformal coating, the printed-wiring assembly shall meet the resistivity of solvent extract test specified in MIL-P-28809. Written evidence of the results of the resistivity of solvent extract tests shall be maintained by the supplier.

40.10 Measling. Measling on printed-wiring boards shall not be continuous between conductive areas, shall not be concentrated in localized areas, and shall not cover more than 5 percent of the total printed-wiring board surface area.

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

40.11.1 Rivets. Tubular rivets shall be free of obvious damage and circumferential cracks. Radial cracks must not extend into the barrel of the rivet. No more than three radial cracks per rivet are allowed. No splits are allowed. Rivets shall be tightly secured and exhibit proper rollover (see figure 53).

40.11.2 Metallic surfaces. All 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 .010 inch (0.25 mm) deep by .030 inch (0.76 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. The area of repair shall not exceed 5 percent of the total metallic surface area.

40.11.3 Nonmetallic surfaces. All 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.

40.12 General workmanship for printed-wiring boards. Printed-wiring boards shall show no evidence of blistering, chipping, gouging, delamination, burning, or charring. All board edges shall be clean cut with no evidence of chipping, cracking, or delamination. All board surfaces shall show no evidence of lifted conductors or raising of surfaces around holes. The printed-wiring boards shall be uniform in quality and free from dirt, oil, corrosion, corrosion products, salts, smut, grease, fingerprints, mold release agents, foreign matter, flux residue, and other defects that will affect life, serviceability, appearance, or any combination of these.

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

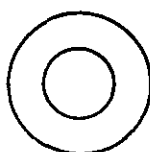
40.13.1 Encapsulation. Encapsulants used on printed-wiring assemblies shall be continuous, homogenic, fully cured and shall cover all components, leads, and circuitry as specified on the printed-wiring assembly drawing. Pits, pinholes, or voids not exceeding .010 inch (0.25 mm) deep by .030 inch (0.76 mm) diameter or scratches not exceeding .020 inch (0.51 mm) wide by .500 inch (12.70 mm) long and .010 inch (0.25 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.

40.13.2 Bonding. Adhesives or bonding agents used on printed-wiring 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, blemishes, 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.

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UNACCEPTABLE



ACCEPTABLE



UNACCEPTABLE

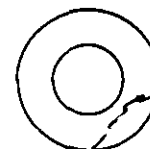


UNACCEPTABLE

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

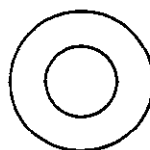


UNACCEPTABLE

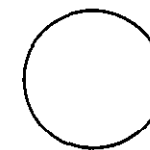


UNACCEPTABLE

SPLITS ARE ALWAYS UNACCEPTABLE



ACCEPTABLE



UNACCEPTABLE

ROLLOVER

FIGURE 53. Rivet inspection.

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40.14 Conformal coating. With the exception of potted or encapsulated assemblies, all printed-wiring assemblies shall be conformally coated with a coating material conforming to MIL-I-46058. The coating shall be applied to all surfaces of the cleaned printed-wiring assembly including the part leads. These assemblies shall be cleaned of flux and other contaminants prior to the application of coating. The conformal coating shall be compatible with all parts of the printed-wiring assembly and the thickness shall be $.003 \pm 0.002$ inch (0.08 ± 0.06 mm) for types ER, UR, and AR, and $.005 \pm .003$ inch (0.13 ± 0.08 mm) for type SR when measured on a flat unencumbered surface. For type XY coating, the thickness shall be in the range of .0005 to .002 inch (0.013 to 0.05 mm) when measured using a micrometer or instrument accurate to .0001 inch (0.003 mm) or by any optical method. Written evidence of the specified conformal coat thickness (depending on the type used) must be maintained by the supplier for a minimum of three years. This evidence may be maintained on a sample basis utilizing actual hardware or a test coupon. Assemblies having adjustable parts shall not have the adjustable portion covered by the coating. Electrical and mechanical mating surfaces, such as connector contact points, screw threads, bearing surfaces, and so forth, shall not be coated. Surfaces such as fins or other extensions which are necessary to ensure proper convective or conductive heat transfer from the printed-wiring assembly shall not be coated. The coated assemblies shall have no blisters, cracking, peeling, wrinkles, mealing, or evidence of reversion or corrosion. No pinhole or bubble or combination of pinholes and bubbles shall bridge more than 50 percent of the distance between conductors. 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.

40.15 Exposed copper. Exposed copper on clipped parts leads shall be permitted.

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Custodians:

Army - ER
Navy - EC
Air Force - 85

Review activities:

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

Preparing activity:
Navy - EC

Agent:
DLA - ES

(Project 5963-0030)

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THICK FILM MULTILAYER INTERCONNECT BOARD DESIGN REQUIREMENTS

10.0 SCOPE

10.1 Scope. This specification 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.

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

20.0 REFERENCED DOCUMENTS

20.1 Industrial. The following documents form a part of this specification to the extent specified herein.

ANSI-Y14.1 Drawing Sheet Size and Format

ANSI-Y14.5 Dimensioning & Tolerancing for Engineering Drawings

ISHM-1402 Hybrid Circuit Design Guide

IPC-D-350 End Product Description in Numeric Form

30.0 REQUIREMENTS

30.1 Terms and Definitions

The terms and definitions used herein shall be in accordance with this specification, ISHM-STD-1402, MIL-M-38510, and MIL-M-28787 Appendix B.

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

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

30.1.3 Conductor. All metal used for electrical interconnection.

30.1.4 Datum. A defined feature such as a point, line, or pad used to locate the pattern or layer for manufacturing and/or inspection purposes.

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30.1.5 Dielectric. An insulating material used to electrically isolate conductors.

30.1.6 Hole. A designed opening in the ceramic blank.

30.1.7 Layer. An individual deposition of conductive material comprised of conductors and/or terminations.

30.1.8 Make-up-interconnect layer. A layer that serves to prevent excessive via length, and/or accommodates additional conductor lines.

30.1.9 Master Drawing. A documentation set which contains all information required to describe a MIB, including the master pattern.

30.1.10 Master Pattern. 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 (MIB). A ceramic circuit board containing two or more layers of interconnection separated by dielectric.

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

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

30.1.14 Via. A designed opening in the dielectric.

30.1.15 Via Fill. Conductive material within the dielectric vias which form the interconnect between metal layers.

40.0 GENERAL DESIGN REQUIREMENTS

40.1 Design Features. The design features of the MIBs shall be in accordance with this specification 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.

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- 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 specification.
- g. Minimum line width, spacing, via size, pad 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(s) of the multisheet master drawing set shall establish the size and shape of the MIB and location of the final pad 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.

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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 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.

40.2.7 Conflict. In the event of any conflict between the master drawing and the requirements of this specification, a copy of the master drawing shall be submitted to the contracting Government agency concerned, with information justifying the deviation(s) and with a request for approval of the deviation(s). When approved, the provisions of the master drawing(s) shall govern. If approvals for deviations from this specification have been given, the deviation(s) shall be indicated on the master drawing.

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 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 radius of the true grid position, when measured at 20° \pm 1°C, and 50 \pm 5 percent relative humidity after the material has stabilized.

50.0 DETAILED END ITEM 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 in width. Solderable conductive pattern shall be a minimum thickness of 0.0007 inch for Type 2 and 0.0005 inch for Type 1. Inner layer conductor thickness shall be a minimum of 0.0004 inch.

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.

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50.1.2 Conductor Spacing. The minimum spacing between vias shall be 0.008 inch. The minimum spacing between all other conductive elements on an individual conductor layer shall be 0.005 inch. (See Figure 54).

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.

50.1.3.2 Connector pads to the edge of the ceramic and dielectric. Connector pads located on the ceramic base shall be spaced a minimum of 0.010 inch from the edge of the ceramic. Connector pads located on dielectric shall be spaced a minimum of 0.005 inch from the edge of the dielectric.

50.1.3.3 Component mounting pads to edge of top dielectric. Spacing from the component mounting pads to edge of top dielectric shall be a minimum of 0.010 inch.

50.2 Vias.

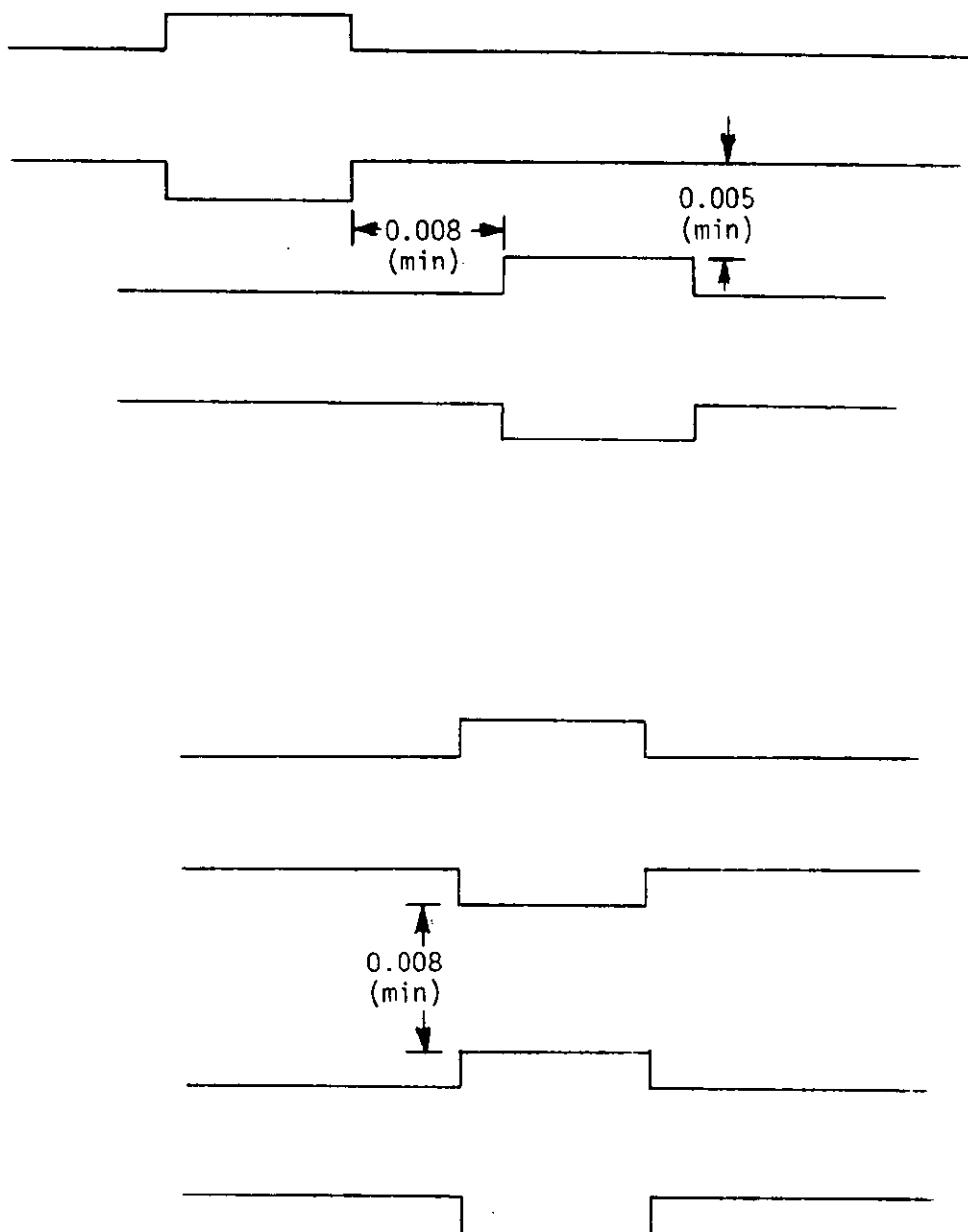
50.2.1 Via Size. Vias shall be a minimum of 0.008 inch square, or equivalent cross sectional area. If non-square vias are used the minimum linear dimension shall be 0.008 inch. Maximum depth of any stacked via fills shall not exceed 0.008 inch.

50.2.2 Vias to edge of dielectric. Edge of vias to edge of dielectric shall be a minimum of 0.010 inch.

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 55).

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FIGURE 54. Conductor spacing.

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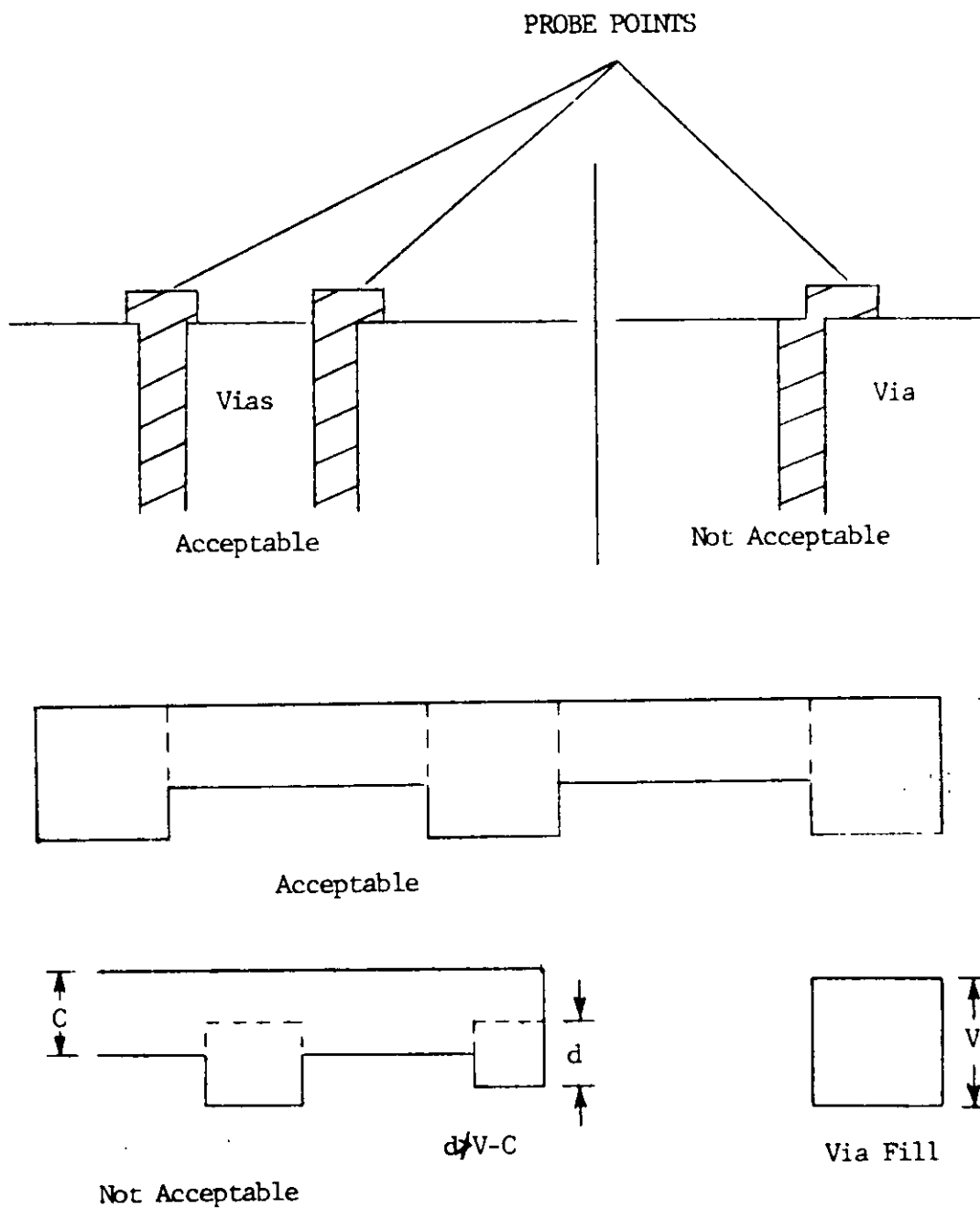


FIGURE 55. Via alignment.

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50.3 Dielectric.

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

50.3.2 Dielectric to edge of ceramic. The spacing between dielectric and edge of substrate shall be 0.010 inch minimum except in the connector pad area where the minimum spacing shall be 0.005 inch.

50.4 Overglaze

50.4.1 Overglaze Thickness. The minimum total thickness of the overglaze shall be 0.001 inch, with a minimum of two (2) depositions required. The overglaze coating shall completely cover the circuitry including the edges of the dielectric, except for the probe points. Overglaze is mandatory on MIB's utilizing a copper thick film system whose dielectric does not meet the overglaze hermeticity current leakage requirements of MIL-M-28787C Appendix B.

50.5 Soldering Terminations

50.5.1 Leaded Component Pads. MIB pads shall have a minimum width equal to the component lead width and a minimum length equal to twice the component lead width or 0.030 inch, whichever is greater. (See Figure 56).

50.5.2 Leadless chip carriers (LCC) pads. The MIB pad 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 added to the length. The MIB pad 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 57). The spacing between LCC's shall be a minimum of 0.050 inch.

50.5.3 Chip Capacitor and Chip Resistor Design Requirements. The MIB pad 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. The MIB pad shall extend the same distance beyond the end of the chip as the metallization on the underside of the chip, or 0.015 inch whichever is smaller. The MIB pad shall extend beyond the side of the chip component a minimum of 0.010 inch. (See Figure 58). Designs which utilize parts which do not have metallization on the sides are not required to have MIB pad extension on the side.

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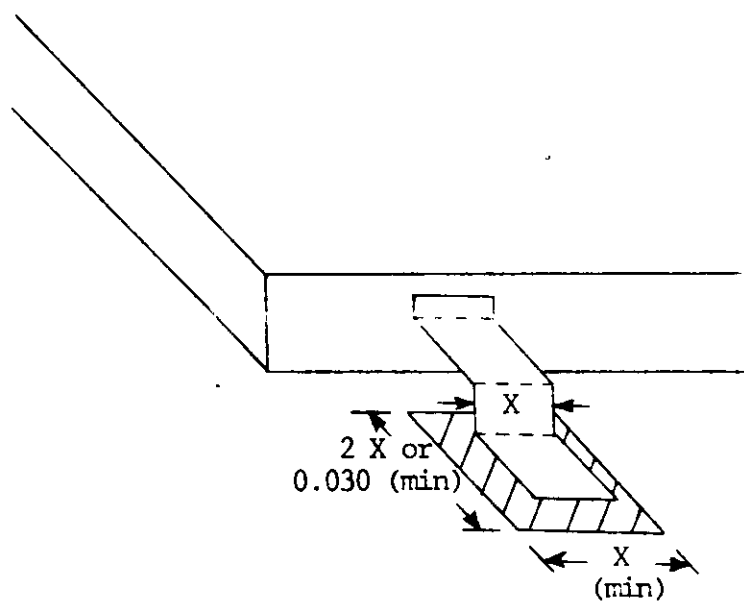
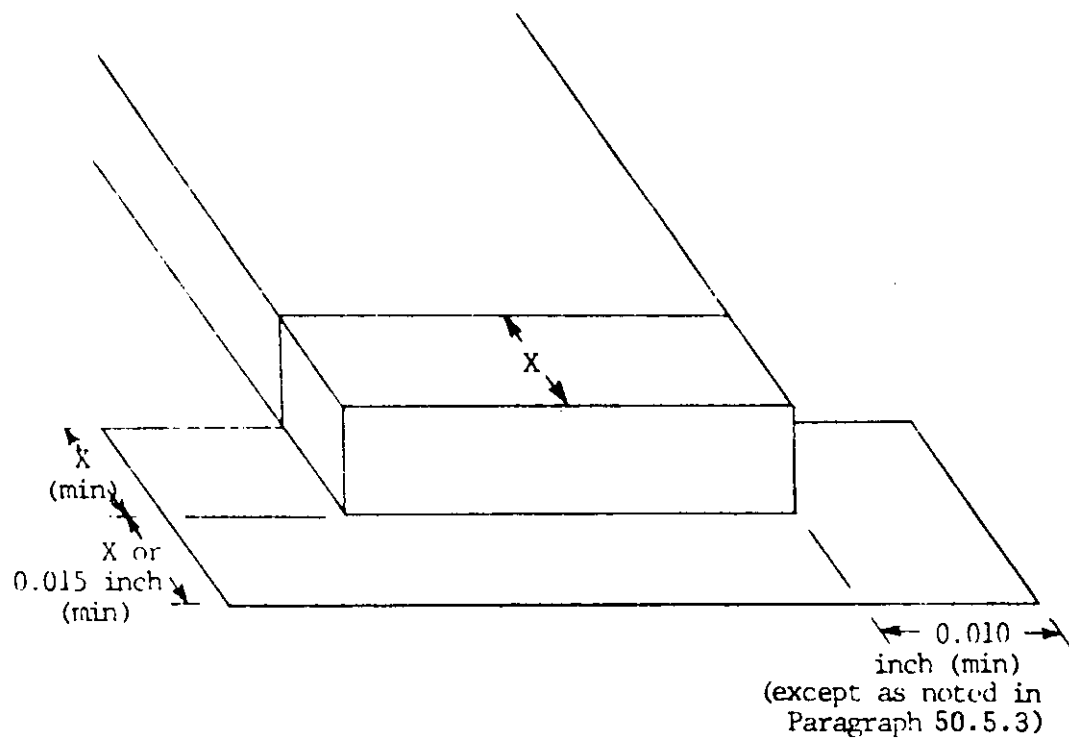


FIGURE 56. Leaded component pads.

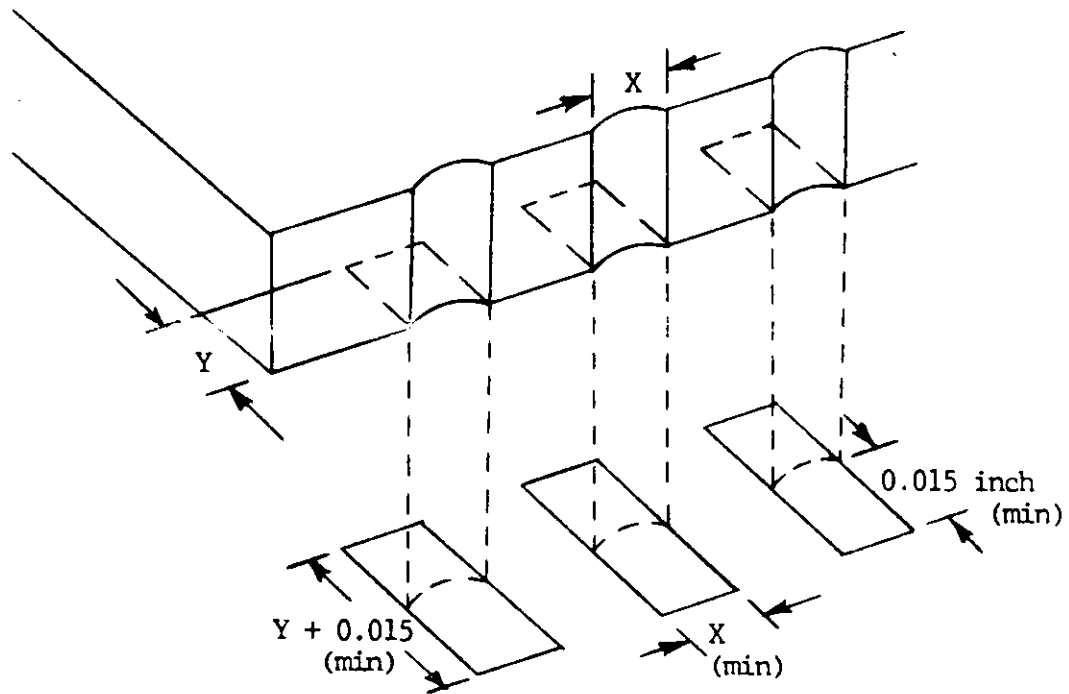
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FIGURE 57. Leadless chip carrier pads.

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FIGURE 58. Chip capacitor and chip resistor pads.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER		2. DOCUMENT TITLE					
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)					
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR					
		<input type="checkbox"/> USER					
		<input type="checkbox"/> MANUFACTURER					
		<input type="checkbox"/> OTHER (Specify): _____					
5. PROBLEM AREAS							
a. Paragraph Number and Wording:							
				b. Recommended Wording:			
				c. Reason/Rationale for Recommendation:			
6. REMARKS							
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional					
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)					

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