

INCH-POUND

  
MIL-S-13949H  
AMENDMENT 2  
29 February 1996  
SUPERSEDING  
AMENDMENT 1  
30 September 1993

MILITARY SPECIFICATION  
SHEET, PRINTED WIRING BOARD  
GENERAL SPECIFICATION FOR

This amendment forms a part of MIL-S-13949H, dated 31 March 1993,  
and is approved for use by all Departments and Agencies of the  
Department of Defense.

The attached insertable replacement pages listed below are replacements for stipulated pages. When new pages have been entered in the document, insert the amendment as the cover sheet to the specification.

| <u>Replacement page</u> | <u>Page replaced</u> |
|-------------------------|----------------------|
| 3                       | 3                    |
| 4                       | 4                    |
| 9                       | 9                    |
| 10                      | 10                   |
| 11                      | 11                   |
| 12                      | 12                   |

PAGE 1

- DD Form 1426 block, delete "US Army Research Laboratory ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5601" and substitute "Defense Electronics Supply Center, ATTN: DESC-ELST, 1507 Wilmington Pike, Dayton, OH 45444-5764".

PAGE 2

- 1.2.1.1.2, after the first sentence add: "E - Epoxy, non-flame retardant."

PAGE 5

- 1.2.1.2.2, delete in its entirety and substitute the following:

"1.2.1.2.2 Reinforcement style. The reinforcement style is identified by four digits that indicate the general parameters (thickness, thread count and weight) of a particular reinforcement material. Unless otherwise specified (see 3.1 and 6.2r, v, and ab), the standard reinforcement style designators listed in table 1 are used to identify form, fit and function of the reinforcement. If a reinforcement style contains only three digits, use a zero preceding the designator; for example, "0108" represents reinforcement style 108. For nonreinforced prepreg, use the designation "0000" (four zeros)."

PAGE 6

- 2.1.1, SPECIFICATIONS, MILITARY, delete "MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base)."
- 2.1.1, STANDARDS, MILITARY, delete "MIL-STD-45662 - Calibration Systems Requirements."
- 2.2, THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC), add the following new publication: "J-STD-003 - Solderability Tests for Printed Boards."

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- 2.2, Add the following new entry.

"NATIONAL CONFERENCE OF STANDARDS LABORATORIES

"NCSL Z540 - General Requirements for Calibration Laboratories and Measuring and Test Equipment

"(Application for copies should be addressed to the National Conference of Standards Laboratories, 1800 30th Street, Suite 305B, Boulder, CO 80301-1032)."

PAGE 7

- 3.2.1, 3.2.2, and 3.2.3, delete in their entirety.

PAGE 13

Footnote 3/, delete in its entirety and substitute the following:

"3/ For some base material types, laminates below certain base thickness may not be producible, e.g., types GT, GX, and GY under .010 inch (0.25 mm) core thickness may not be available."

PAGE 17

3.8, after first paragraph, add: "Unless otherwise specified (see 6.2p), double clad laminates with different metal foil weights on each side shall be marked on the side of the greater foil weight."

- Add new 3.8.1 as follows:

"3.8.1 Substitutability of grades of pits and dents or class of tolerance thickness. Laminates qualified, certified or marked to a higher grade of pits or dents or tighter class of base material thickness tolerance, with procuring activity approval, are substitutable for laminates qualified, certified or marked to a lesser grade of pits and dents or less constricting class of base material thickness tolerance, provided all other values, such as base material type and thickness and metal foil type and weight, are the same. The substitutable laminates shall not be remarked unless specified in the contract or purchase order (see 6.2af). In the event the grade of pits and dents or class of base material thickness tolerance is remarked, the lot date codes for the laminates shall not be changed."

PAGE 18

- 4.1.2, delete in its entirety and substitute the following:

"4.1.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be established and maintained by the manufacturer. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with NCSL-Z540. The use of a non-Government laboratory for qualification and group C inspection is for an established period, and is subject to a 2-year periodic reaudit by the qualifying activity."

- TABLE VI, applicable specification column: Delete "IPC-MF-150".

PAGE 19

- 4.5.2.1, delete in its entirety.

- 4.5.5, delete in its entirety and substitute the following:

"4.5.5 Retention of qualification. To retain qualification, the manufacturer shall verify in coordination with the qualifying activity the capability of manufacturing products which meet the performance requirements of this specification. Refer to the qualifying activity for any additional guidelines necessary to retain qualification to this specification. The manufacturer shall immediately notify the qualifying activity at any time that the inspection data indicates failure of the qualified product to meet the performance requirements of this specification."

PAGE 24

- 4.6.1.2.1.2, delete in its entirety and substitute the following

"4.6.1.2.1.2 Prepreg rolls and sheets. One yard (914.4 mm) at the beginning and end of each roll of reinforcement material."

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## PAGE 25

- TABLE X, Number of specimens to inspect column, delete "100 percent" and substitute "1/" (3 places).
- TABLE XI, delete in its entirety and substitute the following:

"TABLE XI. Sampling plan for group A inspection (laminated base materials)."

| Lot size <u>1/</u> | Sample size | Acceptance number | Lot size <u>1/</u> | Sample size | Acceptance number |
|--------------------|-------------|-------------------|--------------------|-------------|-------------------|
| 2 to 50            | 5           | 0                 | 281 to 500         | 16          | 0                 |
| 51 to 90           | 7           | 0                 | 501 to 1,200       | 19          | 0                 |
| 91 to 150          | 11          | 0                 | 1,201 to 3,200     | 23          | 0                 |
| 151 to 280         | 13          | 0                 | 3,201 to 10,000    | 29          | 0                 |

1/ If the lot size is smaller than the sample size, test all of the pieces."

## PAGE 26

- TABLE XII, Inspection row, Specimen (form and dimension) column, after "Specimen" add "3/".
- TABLE XII, under footnote 2/, add the following new footnote: "3/ Alternate specimen forms and dimensions shall be as specified in the applicable IPC-TM-650 test method."

## PAGE 27

- 4.6.1.3.1.1, delete in its entirety and substitute the following:  

"4.6.1.3.1.1 Laminate. For each inspection lot (see 4.6.1.1b) the sample shall be a minimum of one randomly selected sheet, as pressed."
- 4.6.1.3.2, delete in its entirety and substitute the following:  

"4.6.1.3.2 Rejected lots. If an inspection lot of laminates (see 4.6.1.1b) or prepregs (see 4.6.1.1c) is rejected, the contractor may rework it to correct the defects and resubmit the lot for reinspection, or screen out the defective units (if possible). Such lots (reworked or screened) shall be clearly identified as reinspected lots."
- 4.6.2.1, delete in its entirety and substitute the following:  

"4.6.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in table XIII at a laboratory which has obtained laboratory suitability status from the qualifying activity. Group C inspection shall be made on sample sheets selected from inspection lots which have passed the groups A and B inspection."

## PAGE 29

- TABLE XIV, delete in its entirety and substitute the following:

"TABLE XIV. Sampling plan for group C inspection (laminate)."

| Total number of sheets produced during each sampling period | Sample size | Acceptance number <u>1/</u> |
|---|-------------|-----------------------------|
| 200 or less <u>2/</u>                                       | 1           | 0                           |
| 201 to 1,000 inclusive                                      | 2           | 0                           |
| 1,001 to 10,000 inclusive                                   | 3           | 0                           |
| 10,001 or more  | 4           | 0                           |

1/ If one or more defects are detected, the lot shall be rejected.

2/ One press load or 200 sheets, whatever is greater (the 200 sheets can be from consecutive press loads)."

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- TABLE XV, delete in its entirety and substitute the following:

"TABLE XV. Sampling plan for group C inspection (prepreg)

| Total linear yardage produced during each sampling period | Sample size <sup>1/</sup> | Acceptance number <sup>2/</sup> |
|---|---------------------------|---------------------------------|
| 800 or less   | 1                         | 0                               |
| 801 to 22,000   | 2                         | 0                               |
| 22,000 or more  | 3                         | 0                               |

- <sup>1/</sup> Each sample shall be 2 linear yards (1.83 meters).  
<sup>2/</sup> One or more defects shall constitute failure."

PAGE 32

- 4.8.3.3, first sentence, after "IPC-S-804": Add "or J-STD-003".

PAGE 33

- 4.8.3.6, delete in its entirety and substitute the following:

"4.8.3.6 Thermal stress (see 3.7.3). The test for thermal stress shall be performed in accordance with IPC-TM-650, method 2.4.13.1."

- 4.8.3.6.1, 4.8.3.6.2, and 4.8.3.6.3, delete in their entirety with no substitute.

PAGE 38

- 6.2, after last paragraph, add the following new subparagraphs:

- "aa. Weight or thickness of metal or copper foil designated by 'X' (see 1.2.1.1.3.3).
- "ab. Parameters of a reinforcement material or style not specified (see 3.4.1).
- "ac. Requirement for a certificate of conformance, how/when it is to be supplied and what information it is to contain (see 3.2.1).
- "ad. Weight tolerance of copper or metal foil (see 3.4.3).
- "ae. Design or construction of laminates or prepregs (see 3.4.4 or 3.4.5).
- "af. Remarking of substitutable laminates (see 3.8.1)."

PAGE 39

- 6.3, delete "US Army Research Laboratory, ATTN: AMSRL-EP-RD, Fort Monmouth, NJ 07703-5601; however, information pertaining to qualification of products may be obtained from the".

NOTE: The margins of this amendment are marked with asterisks to indicate where changes (addition, modification, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

## CONCLUDING MATERIAL

Custodians:  
Army - ER  
Navy - EC  
Air Force - 85

Preparing activity:  
DLA - ES

(Project 5998-0064)

Review activities:  
Army - AR, MI  
Navy - AS, CG, MC, OS, SH  
Air Force - 11, 16, 19, 99

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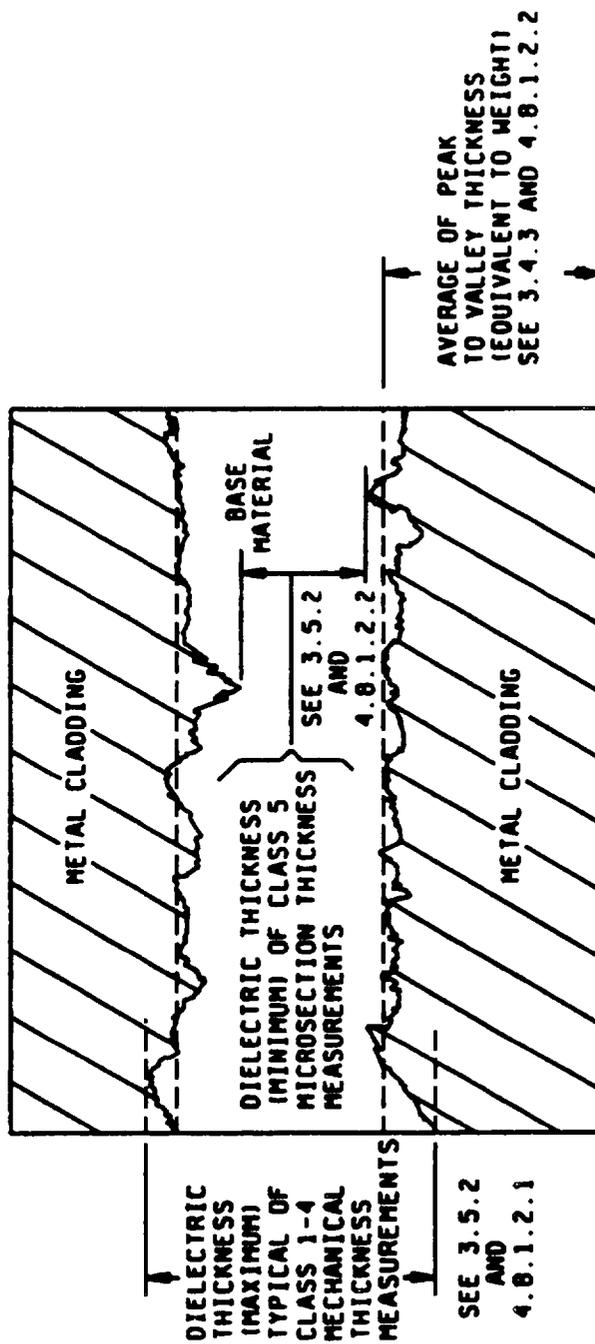


FIGURE 1. BASE MATERIAL AND METAL CLADDING THICKNESS MEASUREMENTS.

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1.2.1.1.3.1 Type of copper foil: The type of copper foil used for the metallic cladding is identified by the following letters

- A - Copper, wrought, as rolled (IPC-MF-150, grade 5).
- B - Copper, wrought.
- C - Copper, electrodeposited (IPC-MF-150, grade 1).
- D - Copper, electrodeposited, double treat (IPC-MF-150, grade 1).
- E - Copper, electrodeposited.
- G - Copper, electrodeposited, high ductility (IPC-MF-150, grade 2).
- H - Copper, electrodeposited, high temperature elongation (IPC-MF-150, grade 3).
- J - Copper, electrodeposited, annealed (IPC-MF-150, grade 4).
- K - Copper, wrought, light cold rolled (IPC-MF-150, grade 6).
- L - Copper, wrought, annealed (IPC-MF-150, grade 7).
- M - Copper, wrought, rolled, low temperature annealable (IPC-MF-150, grade 8).
- P - Copper, electrodeposited, high temperature elongation, double treat (IPC-MF-150, grade 3).
- T - Copper foil parameters as dictated by contract or purchase order (see 6.2h).

1.2.1.1.3.2 Other metal foil: The type of metal foil, other than copper, used for the metallic cladding is identified by the following letters:

- U - Aluminum.
- Y - Copper invar copper.
- N - Nickel.
- O - Unclad.
- Z - Metal foil, other than copper, parameters as dictated by contract or purchase order (see 6.2h).

1.2.1.1.3.3 Nominal weight or thickness of metal foil: The nominal weight of copper foil used for the metallic cladding is designated by either a alpha or numeric character, depending on the desired nominal weight in ounces per square foot (oz/ft<sup>2</sup>). The thickness designator uses the actual number for nominal weights of 1 oz/ft<sup>2</sup> through 9 oz/ft<sup>2</sup> and the following letters for metal foil under 1 oz/ft<sup>2</sup>. For any weight in oz/ft<sup>2</sup> not expressed by a single digit (e.g., 1.5 or 10 oz/ft<sup>2</sup> copper foil), the designator "X" is used and the thickness parameters should then be dictated by contract or purchase order (see 6.2h, i, and aa).

- E - 0.125 oz/ft<sup>2</sup>.
- Q - 0.25 oz/ft<sup>2</sup>.
- T - 0.375 oz/ft<sup>2</sup>.
- H - 0.50 oz/ft<sup>2</sup>.
- M - 0.75 oz/ft<sup>2</sup>.
- O - Unclad (no metallic cladding).
- X - Weight not expressed by a single digit designator or any thickness.

1.2.1.1.4 Grade of pits and dents: The grade of pits and dents is identified as either grade A, B, C, or D (see 3.7.1.1).

1.2.1.1.5 Class of thickness tolerance: The class of thickness tolerance is identified as either class 1, 2, 3, 4, or 5 (see 3.5.2).

1.2.1.1.6 Class of bow and twist: The class of bow and twist is identified by either class C or X. Class C is applicable to laminate with a thickness of .020 inch (0.51 mm) or greater, while class X indicates bow and twist requirements are not applicable (see 3.7.2).

1.2.1.2 Prepreg (reinforced and nonreinforced): The type designation for prepreg is in the following form, and as specified (see 3.1 and 6.2). Prepreg material is distinguished from laminate by the letter "P", designating the construction as a resin preimpregnated reinforcement, followed by the base material designator. The reinforcement material fabric style, nominal resin flow, nominal scaled flow thickness, nominal gel time, and nominal resin content are process parameters normally dictated by the printed wiring manufacturing process. Unless design constraints dictate, these values should not be included on the master drawings, but should only be specified and used in procurement specifications by the printed wiring board manufacturer. An asterisk can be used to replace each digit on the master drawing.

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3.2.1 **Certificate of conformance.** When specified by contract or purchase order (see 6.2ac), a certificate of conformance for compliant laminate or prepreg shall be forwarded to the procuring activity. Unless otherwise specified by contract or purchase order (see 6.2ac), the certificate of conformance for compliant laminate or prepreg shall include the following information, as a minimum:

- a. The full military specification number (with revision level and amendment) and the associated laminate or prepreg specification sheet number (with revision level and amendment).
- b. The full military type designation(s) (see 1.2.1).
- c. The complete qualification reference number(s) (QRN) as assigned by the qualifying activity.
- d. The date of transaction.
- e. The name of the company official approving the certificate of conformance.

Each manufacturer shall have a method for authenticating the approval of certificate of conformance for laminated and prepreg compliant to this document. The method used for authenticating the approval of certificate of conformance shall be made available for qualifying activity review upon request.

3.2.2 **Authorized Distributors.** The manufacturer shall have an established method for oversight of its laminates and prepregs provided through authorized distributors.

3.3 **Terms and definitions.** For the purposes of this specification, the terms and definitions of IPC-T-50 and those contained herein and in the associated specification sheet shall apply.

3.4 **Material.** The material shall be as specified by the procuring activity (see 1.2). The materials specified herein are recommended, but are not mandatory. If materials needed in the production of laminates or prepregs are not specified by the procuring activity, then it is the manufacturer's responsibility to use materials which will enable the laminate or prepreg to meet the performance requirements of this specification and the applicable specification sheet. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

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3.4.1 **Reinforcement material.** Unless otherwise specified (see 3.1 and 6.2r, 6.2v and 6.2ab), the general form, fit, and function parameters of the reinforcement style shall be as described in accordance with table I.

3.4.1.1 **Fabric style.** The reinforcement material used to produce prepreg under this specification shall be as specified by the procuring activity (see 1.2.1.2.2).

3.4.2 **Resin system.** The resin systems used to produce laminate and prepreg under this specification shall be as specified in 1.2.1.1.1.2 or the individual specification sheet. The composition of any laminate or prepreg represented by the manufacturer's designation or type number shall be within the following limitations:

- a. The absolute amount of any component material (resin composition, curing agent, opacifier, fire resistant additive, etc.) may be varied within a total amount of  $\pm 2.5$  percent by weight of that component material.
- b. The chemical species of a coloring or tinting material may be changed if the color or tint is not substantially changed, and if the absolute amount of the coloring or tinting material is not changed by more than  $\pm 2.5$  percent.
- c. There shall be no additions or deletions to the composition.

The manufacturer's designation or type number shall not be included on the master drawings, but shall only be specified and used in acquisition documents by the printed wiring board manufacturer.

3.4.3 **Metal foil.** The copper or metal foil used to produce metal clad laminates under this specification shall be as specified by the procuring activity (see 1.2.1.1.3 and 6.2h).

3.4.3.1 **Weight tolerance.** Unless otherwise specified (see 6.2ad), the copper foil tolerance by weight shall be class I for types C, D, G, H, and J and class II for types A, B, K, L, and M as specified in table II.

3.4.4 **Reinforced laminate.** Unless otherwise specified (see 6.2ae), reinforced laminates shall consist of one or more layers of reinforcement, preimpregnated with the applicable resin system which may be overlaid with metal foil on one or both sides and bonded together and processed to meet the requirements of this specification, the applicable specification sheet (see 3.1) and the complementary document (see 6.2).

3.4.5 **Prepreg.** Unless otherwise specified (see 6.2ae), prepreg shall consist of a layer of reinforcement, impregnated with a resin system (see 1.2.1.2.2) and the polymer advanced to a B-stage (semicured), and shall meet the requirements of this specification, the applicable specification sheet (see 3.1) and the complementary document (see 6.2).

3.4.6 **Color.** Color shall be as specified by the procuring activity (see 6.2d). If the color is not specified, the laminate or prepreg shall be furnished in natural color. Natural is the color produced by the natural, undyed reinforcement and resin system used.

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\* TABLE I. Reinforcement material characteristics

| Fabric range<br>1/  | Fabric style<br>2/ | Thickness<br>(inches)<br>2/ 3/ | Thread count<br>(WxF/inch)<br>2/ 4/ | Weight<br>2/ 5/ | Fabric range<br>1/  | Fabric style<br>2/ | Thickness<br>(inches)<br>2/ 3/ | Thread count<br>(WxF/inch)<br>2/ 4/ | Weight<br>2/ 5/ |      |
|---------------------|--------------------|--------------------------------|-------------------------------------|-----------------|---------------------|--------------------|--------------------------------|-------------------------------------|-----------------|------|
| A<br>Aramid<br>6/   | 3080               | .002                           | 60 x 60                             | 0.90            | G3<br>E-glass<br>Z/ | 1044               | .0057                          | 44 x 44                             | 5.05            |      |
|                     | 3081               | .002                           | 60 x 60                             | 0.90            |                     | 1528               | .0065                          | 42 x 32                             | 5.95            |      |
|                     | 3500               | .004                           | 34 x 34                             | 1.80            |                     | 7627               | .0065                          | 44 x 30                             | 5.90            |      |
|                     | 3511               | .004                           | 33 x 33                             | 1.71            |                     | 7628               | .0067                          | 44 x 32                             | 6.00            |      |
| G1<br>E-glass<br>Z/ | 104                | .0010                          | 60 x 52                             | 0.56            | Z/                  | 7629               | .0071                          | 44 x 34                             | 6.20            |      |
|                     | 106                | .0012                          | 56 x 56                             | 0.73            |                     | 7637               | .0089                          | 44 x 22                             | 7.00            |      |
|                     | 107                | .0015                          | 60 x 35                             | 1.05            |                     | 7642               | .0099                          | 44 x 22                             | 6.70            |      |
|                     | 108                | .0022                          | 60 x 47                             | 1.40            |                     | 7650               | .0075                          | 44 x 23                             | 6.10            |      |
|                     | 1070               | .0014                          | 60 x 35                             | 1.05            |                     | 7652               | .0087                          | 32 x 32                             | 7.43            |      |
|                     | 1080               | .0020                          | 60 x 47                             | 1.40            |                     | 7660               | .0059                          | 30 x 30                             | 4.73            |      |
|                     | 1280               | .0022                          | 60 x 60                             | 1.58            |                     | Q<br>Quartz<br>8/  | 503                            | .0050                               | 50 x 40         | 3.5  |
| G2<br>E-glass<br>Z/ | 112                | .0036                          | 40 x 39                             | 2.10            | 507                 |                    | .0040                          | 27 x 25                             | 2.0             |      |
|                     | 113                | .0032                          | 60 x 64                             | 2.43            | 525                 |                    | .0030                          | 50 x 50                             | 2.0             |      |
|                     | 116                | .0038                          | 60 x 58                             | 3.10            | 527                 |                    | .0090                          | 42 x 32                             | 5.6             |      |
|                     | 119                | .0038                          | 54 x 50                             | 2.80            | 531                 |                    | .0070                          | 68 x 65                             | 5.2             |      |
|                     | 1116               | .0035                          | 60 x 58                             | 3.06            | 553                 |                    | .0070                          | 36 x 36                             | 5.3             |      |
|                     | 1125               | .0039                          | 40 x 39                             | 2.60            | 557                 |                    | .0060                          | 57 x 31                             | 5.0             |      |
|                     | 1165               | .0042                          | 60 x 52                             | 3.55            | 570                 |                    | .0270                          | 38 x 24                             | 19.5            |      |
|                     | 1316               | .0040                          | 61 x 61                             | 3.18            | 572                 |                    | .0170                          | 17 x 16                             | 9.9             |      |
|                     | 1500               | .0059                          | 49 x 42                             | 4.84            | 581                 |                    | .0110                          | 57 x 54                             | 8.4             |      |
|                     | 1652               | .0045                          | 52 x 52                             | 4.14            | 593                 |                    | .0100                          | 49 x 46                             | 7.5             |      |
|                     | 1675               | .0040                          | 40 x 32                             | 2.88            | 594                 |                    | .0080                          | 20 x 10                             | 2.4             |      |
|                     | 1676               | .0046                          | 56 x 48                             | 4.06            | 4503                |                    | .0050                          | 40 x 31                             | 3.3             |      |
|                     | 2112               | .0030                          | 40 x 39                             | 2.05            | 4581                |                    | .0100                          | 47 x 44                             | 8.5             |      |
|                     | 2113               | .0029                          | 60 x 56                             | 2.30            | S<br>S-glass<br>9/  |                    | 6080                           | .0021                               | 60 x 47         | 1.38 |
|                     | 2116               | .0036                          | 60 x 58                             | 3.10            |                     |                    | 6112                           | .0036                               | 40 x 39         | 2.08 |
|                     | 2119               | .0034                          | 54 x 50                             | 2.80            |                     |                    | 6116                           | .0040                               | 60 x 58         | 3.09 |
|                     | 2125               | .0036                          | 40 x 39                             | 2.54            |                     | 6120               | .0038                          | 60 x 58                             | 3.09            |      |
| 2165                | .0040              | 60 x 52                        | 3.55                                | 6180            |                     | .0020              | 60 x 60                        | 1.55                                |                 |      |
| 2313                | .0030              | 60 x 64                        | 2.40                                | 6313            |                     | .0035              | 60 x 64                        | 2.38                                |                 |      |
| 2316                | .0038              | 61 x 61                        | 3.13                                | 6314            |                     | .0033              | 60 x 64                        | 2.38                                |                 |      |
| 2319                | .0034              | 60 x 46                        | 2.72                                | 6413            |                     | .0034              | 60 x 56                        | 2.30                                |                 |      |
| 3132                | .0028              | 60 x 60                        | 2.32                                | 6628            |                     | .0068              | 44 x 32                        | 5.90                                |                 |      |
| 3070                | .0031              | 70 x 70                        | 2.94                                | 6676            |                     | .0048              | 56 x 48                        | 4.10                                |                 |      |

1/ Extent of qualification only.

2/ Listed for standardization of form, fit and function only.

3/ For reference only. Thickness tolerance is approximately  $\pm 20$  percent.4/ For reference only. Thread count tolerance is approximately  $\pm 5$ .5/ For reference only. Weight is in ounces/square yard. Weight tolerance is approximately  $\pm 5$  percent.

6/ Reinforcement material woven from aramid fibers (see IPC-A-142).

7/ Reinforcement material woven from E-glass fibers (see IPC-EG-140).

8/ Reinforcement material woven from S-glass fibers.

9/ Reinforcement material woven from quartz fibers

Supersedes page 11 of MIL-S-13949H of  
31 March 1993.

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| Weight designator | Nominal weight (oz/ft <sup>2</sup> ) 1/ | Weight tolerance by percent |          | Nominal thickness 2/ inches (microns) | Thickness tolerance (approximately 10%) inches (microns) |
|-------------------|---|-----------------------------|----------|---------------------------------------|--|
|                   |   | Class I                     | Class II |                                       |  |
| E                 | 0.146                                   | ± 10                        | ± 5      | .0002 (5.0)                           | .00002 (0.5)   |
| O                 | 0.263                                   | ± 10                        | ± 5      | .0004 (9.0)                           | .00004 (0.9)   |
| T                 | 0.350                                   | ± 10                        | ± 5      | .0005 (12.0)                          | .00005 (1.2)   |
| H                 | 0.50                                    | ± 10                        | ± 5      | .0007 (17.5)                          | .00007 (1.75)  |
| M                 | 0.75                                    | ± 10                        | ± 5      | .0010 (25.0)                          | .00010 (2.5)   |
| 1                 | 1.00                                    | ± 10                        | ± 5      | .0014 (35.0)                          | .00014 (3.5)   |
| 2                 | 2.00                                    | ± 10                        | ± 5      | .0028 (70.0)                          | .00028 (7.0)   |
| 3                 | 3.00                                    | ± 10                        | ± 5      | .0042 (105.0)                         | .00042 (10.5)  |
| 4                 | 4.00                                    | ± 10                        | ± 5      | .0056 (140.0)                         | .00056 (14.0)  |
| 5                 | 5.00                                    | ± 10                        | ± 5      | .0070 (175.0)                         | .00070 (17.5)  |
| 6                 | 6.00                                    | ± 10                        | ± 5      | .0084 (210.0)                         | .00084 (21.0)  |
| 7                 | 7.00                                    | ± 10                        | ± 5      | .0098 (245.0)                         | .00098 (24.5)  |
| X (10)            | 10.00                                   | ± 10                        | ± 5      | .0135 (343.0)                         | .00135 (34.3)  |
| X (14)            | 14.00                                   | ± 10                        | ± 5      | .0189 (480.0)                         | .00189 (48.0)  |

1/ For reference only. Weight derived by test method 2.2.12 of IPC-TM-650.

2/ For reference only. Thickness derived by microsection in accordance with 4.8.1.2.2.

3.5 Dimensions.3.5.1 Length and width.

3.5.1.1 Length and width of reinforced laminate sheets, panels, and prepreg sheets. Unless otherwise specified (see 6.2), the manufacturers' standard sizes shall be acceptable. Standard size laminates from which specimens have been cut for tests required by this specification shall be acceptable, unless particular dimensions are specified (see 6.2). The permissible variations from the specified length or width shall be as specified in table III. Adjacent edges shall be perpendicular within .003 inch (0.08 mm) per inch for laminate and .005 inch (0.13 mm) per inch for prepreg.

3.5.1.2 Length and width of continuous length reinforced laminates. Unless otherwise specified (see 6.2), the manufacturers' standard sizes shall be acceptable. The tolerance for length and width of standard sizes will be ±.25 inch per 12 inches (±6.4 mm per 30 cm) of length or width.

3.5.1.3 Width of prepreg rolls. Unless otherwise specified (see 6.2), rolls shall be supplied in the manufacturers' standard widths +1.000, -.500 inch (+25.40, -12.70 mm) (inside of selvage).

TABLE III. Permissible variation in length or width.

| Type of material | Permissible variation in panel length or width, ±inches (mm) |                 |                    | All sheets sizes |
|------------------|--|-----------------|--------------------|------------------|
|                  | Less than 12 inches  | 12 to 24 inches | 24 inches and over |                  |
| Laminates        | .031 (0.79 mm)   | .063 (1.60 mm)  | .125 (3.18 mm)     | +1.0, -0.0       |
| Prepreg          | .063 (1.61 mm)   | .125 (3.18 mm)  | .188 (4.78 mm)     | N/A              |

3.5.2 Nominal base material thickness and tolerance of laminates. Unless otherwise specified, the nominal base material thickness (without metal cladding) and tolerances for laminates shall be as specified in table IV when measured in accordance with 4.8.1.2. The thickness of the outer 1.00 inch (25.4 mm) of the trimmed laminate sheet (as manufactured) or cut-to-size panel supplied by the vendor shall not vary from the nominal by a value greater than 125 percent of the specified tolerance. Class of tolerance shall be as specified in the type designation (see 1.2.1.1.5). For classes 1-4, the thickness shall be measured in accordance with 4.8.1.2.1 (mechanical measurement), except for thicknesses below .0035 inch (0.089 mm) which shall be measured in accordance with 4.8.1.2.2. For class 5, the thickness shall be measured via microsection as specified in 4.8.1.2.2. NOTE: Laminate of a specified nominal base material thickness will indicate a greater thickness when measured in accordance with 4.8.1.2.1 than when measured in accordance with 4.8.1.2.2.

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31 March 1993.

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER MIL-S-13949H  
Amendment 2

2. DOCUMENT DATE (YYMMDD) 96-02-29

3. DOCUMENT TITLE: SHEET, PRINTED WIRING BOARD, GENERAL SPECIFICATION FOR

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

#### 5. REASON FOR RECOMMENDATION

#### 6. SUBMITTER

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