

# **MILITARY STANDARD**

## **CONNECTORS, ELECTROMAGNETIC INTERFERENCE (EMI) FILTER CONTACT**



NO DELIVERABLE DATA  
REQUIRED BY THIS DOCUMENT

**FSC 5935**

MIL-STD-2120  
27 August 1984

DEPARTMENT OF DEFENSE

Washington, DC 20363

Connectors, Electromagnetic Interference (EMI) Filter Contact

MIL-STD-2120

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

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### FOREWORD

1. This standard establishes the requirements for an electromagnetic interference (EMI) filter contact connector (hereinafter referred to as FCC). Once determined, the requirements should be incorporated into a specification sheet under the general connector specification covering its mating connector.

2. An EMI FCC shall be a connector containing some filter and ground contacts terminated with a crimp removable socket contact per MIL-C-39029, a .025 inch square solderless wrappost per MIL-STD-1130, or a solder termination. Specific contacts shall be specified on the individual specification sheets.

3. Unless otherwise specified on the individual specification sheet, the ground contact shall be terminated to a non-removable ground plane within the FCC body which is connected to the FCC shell.

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1. SCOPE

1.1 Scope. This standard establishes the requirements for an electromagnetic interference (EMI) filter contact connector (hereinafter referred to as FCC). Once determined, the requirements should be incorporated into a specification sheet under the general connector specification covering its mating connector.

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2. REFERENCED DOCUMENTS

2.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-M-39029 - Contact, Electrical Connector, General Specification For

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts  
MIL-STD-220 - Method of Insertion Loss Measurement  
MIL-STD-704 - Aircraft Electric Power Characteristics  
MIL-STD-1130 - Connection, Electrical Solderless Wrappost  
MIL-STD-1344 - Test Methods for Electrical Connectors

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

2.2 Order of precedence. In the event of conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

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### 3. DEFINITIONS

3.1 Filter contact connector (FCC). An electromagnetic interference (EMI) filter contact connector is a connector containing some filter and ground contacts terminated with a crimp removable socket contact per MIL-C-39029, a .025 inch (0.64 mm) square solderless wrappost per MIL-STD-1130, or a solder termination. Specific contacts shall be specified on the individual FCC specification sheets.

3.2 Ground contact. Unless otherwise specified in the individual specification sheet, the ground contact shall be terminated to a nonremovable ground plane within the FCC body which is connected to the FCC shell.



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#### 4. GENERAL REQUIREMENTS.

4.1 Specification sheets. The individual item requirements shall be as specified herein, in the general connector specification, and in accordance with the applicable specification sheets.

4.2 Filter contact. A FCC shall contain filter contacts of no more than three frequency bands (see table I) in any one insert arrangement. One frequency range band is preferred.

4.3 Ground contact. The ground contact shall be terminated to a nonremovable ground plane within the FCC that is permanently connected to the connector shell.

4.4 Temperature range. The FCC shall have an operating temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  and a nonoperating temperature range of  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

4.5 Intermateability. The FCC shall mate with the applicable connector and shall conform to the intermateability dimension specified in the general connector specification.

4.6 Mounting. Mounting dimensions shall be specified in the FCC specification sheet.

4.7 Contact location. The size and location of each filter and ground contact shall be specified in the FCC specification sheet.

4.8 Mating connector. The FCC specification sheets shall specify the mating connector by part number.

4.9 Environmental requirements. Unless otherwise specified in the FCC specification sheet, the FCC shall meet the environmental requirements of the general connector specification.

4.10 Connector finish. The FCC shall have the same conductive finish and meet the same conductive finish requirements of its mating connector.

4.11 FCC frequency range band. The FCC specification sheets shall specify one and not more than three frequency bands specified in table I for its filter contacts.

TABLE I. Electrical characteristics.

Freq. band	Filter network type	Capacitance (pF)		Cut-off Freq (MHz) (3 dB max)	Minimum attenuation (dB)																	
					25°C ambient temperature (no load)						-55°C to +125°C											
					Test frequencies (MHz)						Test frequencies (MHz)											
					1	3	10	30	100	300	1,000	1	3	10	30	100	300	1,000				
A	C	100	200	30					3	10	20					2	8	17				
B	PI	300	600	8			4	10	32	45			2	8	30	40						
C	PI	500	1,300	4			2	10	22	36	50			8	20	35	45					
D	Distr. Element	1,500	3,000	5			7	12	20	45	60			7	11	14	33	42				
E	PI	1,900	5,000	1			2	10	22	50	50	55			2	8	20	42	55			
F	Distr. Element	4,000	10,000	2			16	14	24	55	100	100			6	8	15	35	80	100		
G	PI	4,000	12,000	0.5			2	4	15	32	50	55	55			2	10	25	50	55		

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4.12 Dissipation factor. The dissipation factor of filter contacts shall be 4 percent.

4.13 Voltage rating. The working voltage rating of the FCC shall be 115 V rms, 60 Hz, and 200 V dc.

4.14 Radio frequency (RF) current rating. Unless otherwise specified on the FCC specification sheets, the RF current rating of filter contacts shall be 0.25 ampere.

4.15 Marking. The outside surface of the connector shell shall be marked with the words "Filter Contacts" in at least two places, shall be of a contrasting color to the basic shell, and shall be readily visible when servicing the mounted FCC (see applicable specification sheet).

4.16 Preparation for delivery. Preparation for delivery shall be in accordance with the general connector specification.

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## 5. DETAIL REQUIREMENTS

5.1 Quality assurance provisions. The quality assurance provisions for a FCC shall be in accordance with the requirements of the general connector specification except as modified or expanded herein.

5.1.1 Qualification and retention of qualification. Qualification and retention of qualification tests shall include those required by the general connector specification and the following additional tests:

- a. Initial attenuation at ambient temperature (swept frequency) (5.2.6.1).
- b. Attenuation with feed-through contact current (5.2.6.2).
- c. Attenuation at temperature extremes (5.2.6.3).
- d. Capacitance, insulation resistance and dielectric withstanding voltage after temperature cycling.
- e. Capacitance, insulation resistance and dielectric withstanding voltage after shock.
- f. Capacitance, insulation resistance and dielectric withstanding voltage after humidity.
- g. RF current (5.2.7).
- h. Voltage spike (see 5.2.8).
- i. Resistance to pin bending (5.2.10).
- j. Filter life (5.2.11).
- k. Final attenuation at ambient temperature (swept frequency) (5.2.6.1).

5.1.2 Quality conformance inspection. Quality conformance inspection shall include group A inspection of the general connector specification with the modifications specified in 5.1.2.1.

5.1.2.1 Modifications. Group A inspection shall include 100 percent testing of all filter contacts in the FCC as follows, except as specified in d below.

- a. Capacitance at ambient temperature (at 100 MHz).
- b. Insulation resistance. 1/
- c. Dielectric withstanding voltage. 1/
- d. Attenuation measurements shall be performed on 10 percent of filter contacts of each frequency band of contacts.

5.2 Methods of examination and testing. Test methods shall be in accordance with the general connector specification except as modified herein.

5.2.1 Dielectric withstanding voltage. The dielectric withstanding voltage, when tested in accordance with the general connector specification, shall be 500 V dc. The dielectric withstanding voltage test should be used with caution particularly in implant quality conformance testing, as even an overpotential less than the breakdown voltage may injure the insulation and thereby reduce its safety factor. Therefore, repeated application of the test voltage on the same specimen is not recommended. In cases when subsequent application of the test voltage is specified in the test routine, it is recommended that succeeding tests be made at reduced potential.

5.2.2 Insulation resistance. Insulation resistance between any pair of contacts and between any contact and shell, when tested as specified in the general connector specification, shall be 5,000 megohms minimum.

1/ May be tested simultaneously.

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5.2.3 Thermal shock. The requirements of the general connector specification shall apply except that the temperature extremes shall be  $-55^{\circ}\text{C}$  and  $+125^{\circ}\text{C}$ .

5.2.4 Altitude-low temperature (where applicable). The low temperature altitude requirements of the general connector specification shall apply except the voltage shall be as specified in the FCC specification sheet.

5.2.5 Contact retention. Contact retention shall be performed on all contact types as specified in method 2007 of MIL-STD-1344. Details and retention values shall be specified on the individual specification sheets. Contact terminations utilizing MIL-C-39029 socket contacts shall be capable of being installed and removed using the tools specified for those contacts.

5.2.6 Attenuation. When tested as specified in 5.2.6.1 at ambient temperature, 5.2.6.2 with feed-through contact current, and 5.2.6.3 at temperature extremes, the attenuation of filter contacts in connectors shall be not less than the values shown in table I or on figure 1.

5.2.6.1 Attenuation at ambient temperature. FCCs shall be measured for attenuation using a measurement system shown on figure 2 or acceptable substitutes approved by the qualifying activity. The attenuation of the sample shall be compared to that of a calibrated attenuator in a 50-ohm system. Unless otherwise specified, all filter contacts in the FCC shall be tested. For qualification testing, initial and final attenuation shall be measured on a swept frequency basis across the frequency band (A, B, and so forth). For intermediate test measurements during qualification, discrete measurements shall be made at 10 MHz or the lowest test frequency indicated in table I and 100 MHz. For acceptance testing, discrete measurements shall be made at 100 MHz. Following are the requirements for the equipment used in the circuit:

- a. Signal generator: The signal generator with an output impedance of 50 ohms shall be capable of an adequate, stable output to ensure a useful indication of the detector within 5 percent of the applicable frequency at the applicable attenuation level.
- b. Isolation pads: The isolation pads shall be 50-ohm coaxial attenuators of 6 to 10 decibels (dB) nominal attenuation with a voltage standing wave ratio (VSWR) of 1.3 or less at the applicable frequency.
- c. Calibrated attenuator: The calibrated attenuator shall be a precision 50-ohm coaxial attenuator, either fixed or variable, with an accuracy of  $\pm 0.1$  dB/10 dB at the applicable attenuation level and frequency.
- d. Test fixture: The test fixture shall provide good electrical contact between the system ground and the filter body and provide adequate shielding. The fixture may include a 50-ohm resistor in series with the filter contact, provided attenuation level requirements are increased by 6 dB. The fixture shall have less than 1.5 VSWR at 100 MHz with a 50 ohm load without a filter inserted.
- e. Switches: The switches shall be 50-ohm coaxial, either manually or electrically operated, with a VSWR of 1.5 or less at the applicable frequency.
- f. Fixture design is to accompany the qualification report with sufficient information to allow evaluation of test results.

5.2.6.2 Attenuation with feed-through contact current. FCCs shall be tested as specified in 5.2.5.1 except that the filter contact under test shall carry dc current specified on figure 1 for the applicable frequency range band for a minimum of 2 minutes before the measurement is made and while the measurement is being made. Twenty percent of the total complement but not less than 10 contacts shall be tested. This test shall be performed at ambient temperature with only the test contact carrying the load current. Attenuation shall be measured at 10 MHz or the lowest test frequency indicated in table I and 100 MHz.

5.2.6.3 Attenuation at temperature extremes.

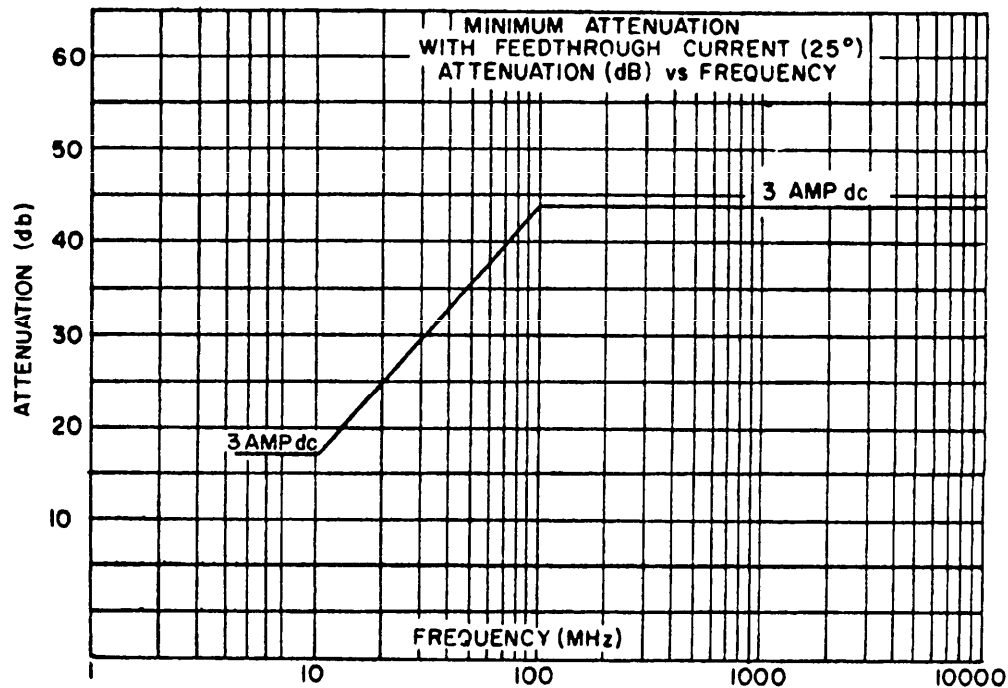


FIGURE 1. Attenuation with feed-through contact current.

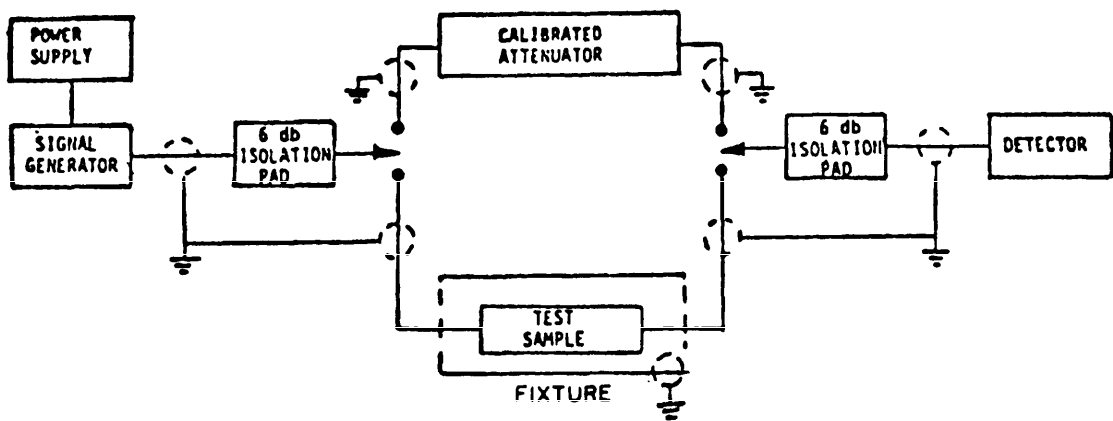


FIGURE 2. Attenuation measurement system.

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5.2.6.3.1 High temperature. FCCs shall be tested as specified in 5.2.6.1 except that the FCC shall be exposed to 125°C for 30 minutes prior to testing and at temperature extreme during the test. Twenty percent of the total compliment but not less than 10 contacts shall be tested. The contacts shall not carry load current. Attenuation shall be measured the lowest test frequency indicated in table I and 100 MHz.

5.2.6.3.2 Low temperature. FCCs shall be tested as specified in 5.2.6.3.1 except that the temperature extreme shall be -55°C. The same contacts shall be tested.

5.2.7 RF current. After testing as specified in 5.2.7.2, filter contacts in connectors shall show no evidence of damage and shall meet the requirements for attenuation specified in 5.2.6 and shall meet the requirements for insulation resistance and dielectric withstanding voltage specified in 5.2.2 and 5.2.1.

5.2.7.1 RF current test (qualification only). A minimum of 10 percent of the total compliment but not less than five filter contacts shall be tested individually in FCCs using the current test procedure shown on figure 3.

5.2.7.2 Procedure for performing RF current test.

- a. Measure attenuation (see 5.2.6).
- b. Vary RF generator frequency until RF ammeter shows peak current (generator loading must be chosen to provide peak current at filter resonance and also not exceed the generator VSWR tolerance). Adjust RF generator output to specified RF current (see 4.14) and dwell for 5 minutes.
- c. Repeat step b. from the opposite side of the filter contact.
- d. Perform attenuation (see 5.2.6), and insulation resistance and dielectric withstanding voltage as specified in the general connector specification.

5.2.8 Voltage transient. When tested as specified in 5.2.8.1, filter contacts in connectors shall withstand the voltage transient defined on figure 4 without evidence of damage and after testing, shall meet the requirements for attenuation specified in table I, and the requirement for resistance and dielectric withstanding voltage specified in the FCC specification sheet.

5.2.8.1 Voltage transient test. Twenty percent of the total compliment but not less than 10 filter contacts in FCCs shall be subjected to the voltage transient defined in MIL-STD-704 (DC normal operation characteristics). Those contacts subjected to the voltage transient shall then be tested for attenuation as specified in 5.2.6, and insulation resistance and dielectric withstanding voltage as specified in the general connector specification.

5.2.9 Contact resistance. Contact resistance requirements are as specified in 5.2.9.1 and 5.2.9.2.

5.2.9.1 Filter contacts. When tested as specified in 5.2.9.1.1, the contact resistance between mated contacts shall be 15 milliohms maximum.

5.2.9.1.1 Filter contact test. Mated filter contacts shall be tested in accordance with method 3004 of MIL-STD-1344. The test current shall be as specified in the FCC specification sheet.

5.2.9.2 Ground contacts. When tested as specified in 5.2.9.2.1, the resistance between the ground contact and the FCC shell shall be 2.5 milliohms maximum.

5.2.9.2.1 Ground contact test. Ground contacts shall be tested in accordance with method 303 of MIL-STD-202. Test points shall be the surface of the ground contact to a point on the connector shell.

5.2.10 Resistance to pin bending. When tested as specified in 5.2.10.1, the pin contact shall not break or fracture. After testing, the filter pin contact shall meet the requirements for attenuation specified in 5.2.6, and the requirements for insulation resistance and dielectric withstanding voltage specified in the FCC specification sheet.

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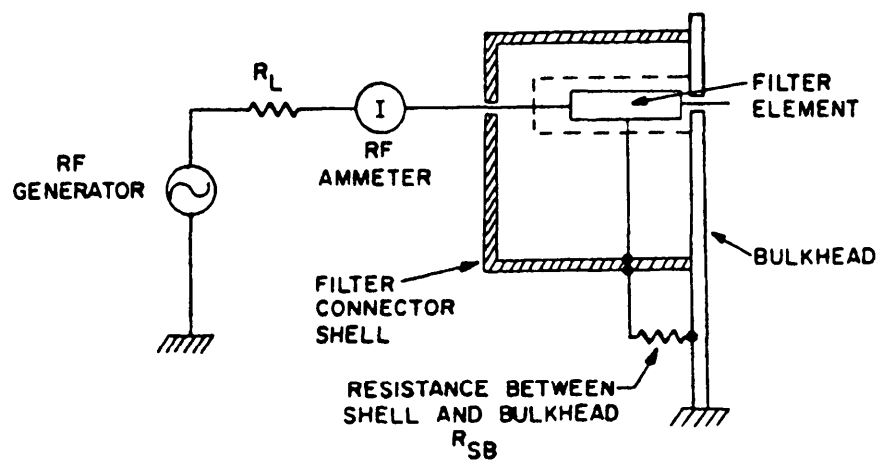
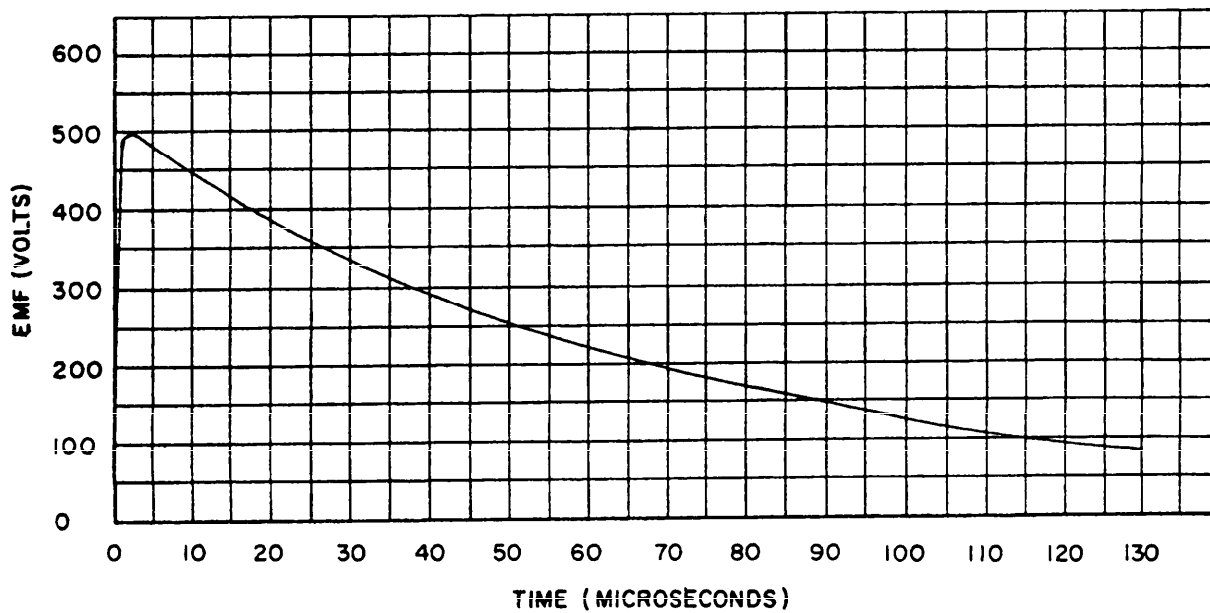
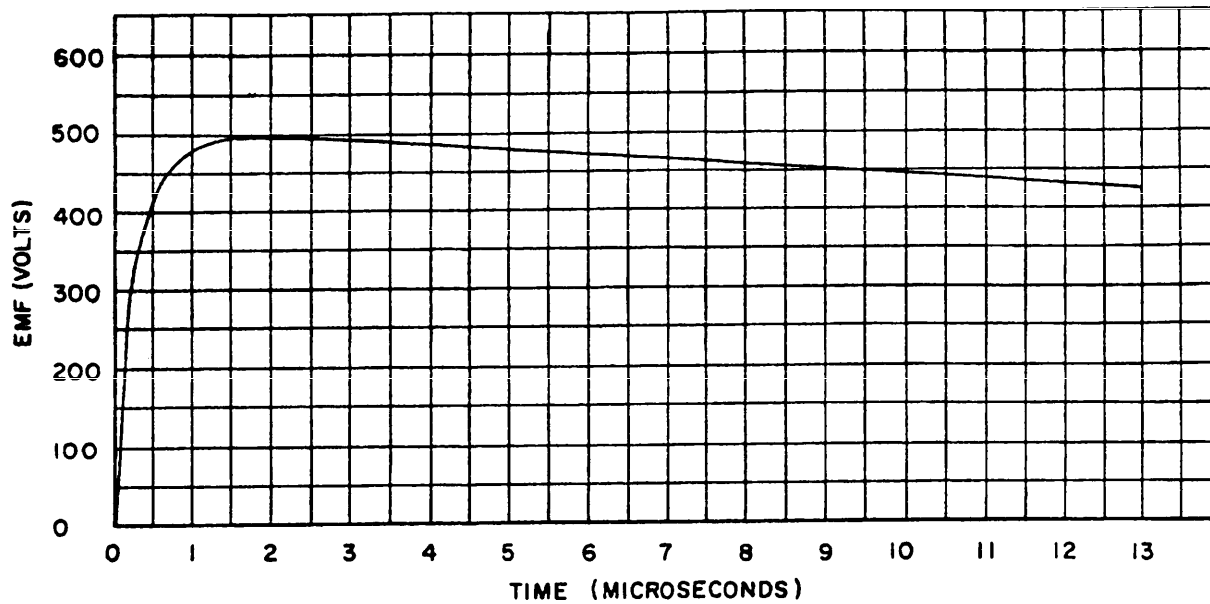


FIGURE 3. RF current test procedure.



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PLOT OF:  $A * (\text{ALPHA} * T) - \text{EXP}(\text{BETA} * T)$

ALPHA = 14000

BETA = .3600000

A = 510

$$E = 1A \left( \frac{-\infty t}{e} - e^{\beta t} \right)$$

FIGURE 4. Voltage transient.

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5.2.10.1 Resistance to pin bending test (pin contacts only). When specified on the individual specification sheets, two pin contacts in the FCC shall be bent 90 degrees at the FCC interface such that they touch the interface grommet. The contacts shall then be straightened and tested for attenuation in accordance with 5.2.6, and insulation resistance and dielectric withstanding voltage in accordance with the general connector specification.

5.2.11 Filter life. After testing as specified in 5.2.11.1, filter pin contacts in connectors shall show no evidence of damage and shall meet the requirements for attenuation specified in 5.2.6, and the requirements for insulation resistance and dielectric withstanding voltage specified in the FCC specification sheet.

5.2.11.1 Filter life test. Twenty percent of the total compliment but not less than 5 filter contacts shall carry the dc current specified in 5.2.6.2 (attenuation with feed-through contact current) for the applicable frequency range band at the rated voltage specified on the FCC specification sheet for 500 hours. FCCs shall be tested at a temperature that will provide a hot spot temperature of 125°C, or as otherwise specified in the applicable connector specification, at the FCC. After the life test, all filter contacts shall be tested for attenuation in accordance with 5.2.6.1, and insulation resistance and dielectric withstanding voltage in accordance with the general connector specification.

5.2.12 Filter contact capacitance. When tested as specified in 5.2.12.1, the capacitance of the filter contacts shall be as specified in table I.

5.2.12.1 Filter contact capacitance test. Contacts shall be tested in accordance with method 305 of MIL-STD-202. Test frequencies and magnitude of the polarization voltage shall be specified on the specification sheet.

5.2.13 Vibration and shock. Vibration and shock shall be tested as specified in the general connector specification with the following exception. Monitoring for discontinuities between mating contacts and between filter contacts and the grounding system shall be accomplished as follows:

- a. Prepare special contacts with gap in ceramic shorted by conductive paint or similar method. This effectively shorts out the filter capacitors.
- b. Assemble these contacts in the connector to be tested.
- c. Connect a mating connector to the test connector.
- d. Wire a sample set of positions of the mating connector. (The sample size will be restricted by the monitoring capacity.)
- e. The return wire should connect to the shell of the test connector.
- f. Insert a detector in each wire of mating connector. This detector must be capable of detecting a 1.0 microsecond interrupt of electrical signal.
- g. Mount the test connector with mating connector on the test fixture for specified test.
- h. Pass 100 mA dc through each sample position. Note: Make sure that the wiring and detector do not interfere with the testing.
- i. Perform the vibration and shock tests.
- j. Monitor 100 mA dc current for 1.0 microsecond interrupt during test and record.
- k. At end of tests, visually examine the test connector for physical damage, e.g., cracks in contacts or inserts, bonding breaks, etc.

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6. NOTES

6.1 Notes. Not applicable.

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

Review activities:  
Navy - AS, MC, TD  
DLA - ES

Agent:  
DLA-ES

Preparing activity:  
Navy - EC  
(Project number 5935-3355)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

*(See Instructions – Reverse Side)*

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