



EMI/EMP FILTER PROTECTION

Amphenol Military & Aerospace

EMI/EMP FILTER PROTECTION OVERVIEW

Amphenol is the **largest manufacturer of military and aerospace interconnect solutions** in the world and has incorporated EMI and EMP filter protection into interconnect solutions for 50 years.

Largest connector portfolio:
Amphenol filters all types of connectors: circular, rectangular, or custom designs

Manufacturing versatility:
Machine, mold, and turn all components; an in-house capacitor manufacturing center of excellence; internal testing capabilities

Technology proliferation from other Amphenol divisions: Can provide proven COTS filter technology from other markets to the military and aerospace markets

Global footprint, local support: Multiple connector manufacturing facilities in North America, Europe, and Asia that support both ITAR and non-ITAR programs

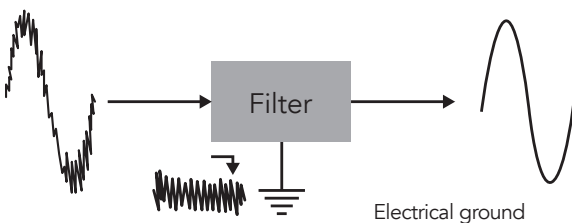
The Basics of Filtering:

Unwanted electrical signals or noise from electronic devices can have harmful effects on equipment. Designers need a way to filter out the noise, or electromagnetic interference (EMI) or pulses (EMP) so it doesn't harm components. Proper EMI filtering is key to ensure equipment operates effectively in severe environments.

Filtering out EMI and meeting Electromagnetic Compatibility (EMC) Requirements are accomplished with two methods:

- Mechanical methods -- Use of special enclosures with shielding, grounding springs, and other standard connector design to reduce radiated EMI.
- Electrical methods -- Use of filter connectors or discrete filters to remove EMI. Discrete filters take the "dirty" signal and filter it at the circuit board. Filter connectors, on the other hand, remove EMI before it enters the unit and eliminates the need for complex circuitry inside the box. Filter connectors are also bi-directional, so the signals are cleaned in both directions.

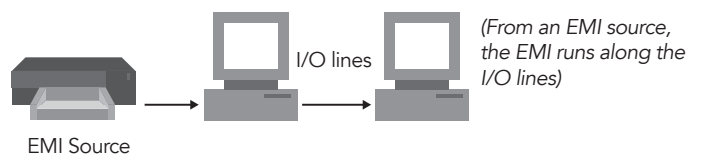
EMI Filter:



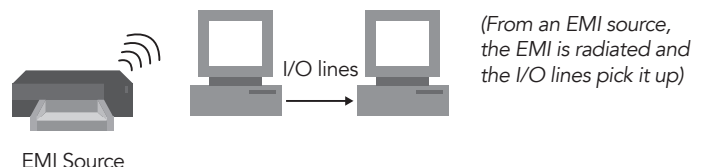
Filter Connector Benefits:

- Effective against both radiated and conducted EMI
- Better performance than discrete filters
- Keep noise and transients outside the unit by grounding them through the shell to chassis
- Cost effective by using fewer components
- Can eliminate or reduce the need for shielded cable
- Tested to Mil-Spec requirements
- Reduced or no solder joints in the case of solderless and crimp termination designs
- Provides high voltage protection to levels up to 2000 VDC
- Available with mixed filter values (including X2Y), ground, and feed-through locations
- Available with high speed contact options

Conducted EMI:



Radiated EMI:

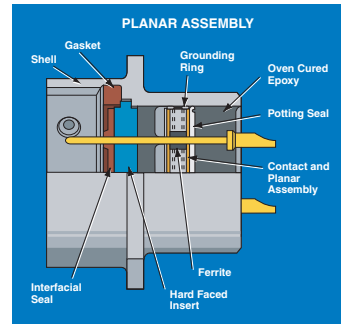
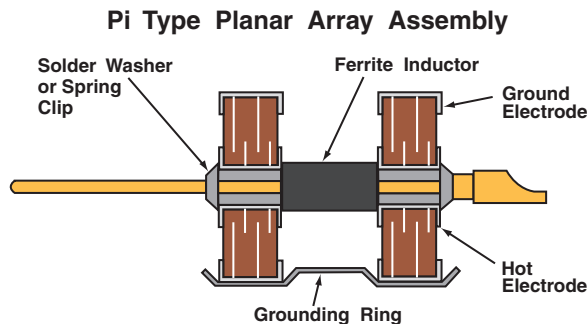


FILTER CONNECTOR TECHNOLOGY

Filter connectors provide cost and space-effective solutions for radiated and conductive EMI problems in a wide range of military and commercial applications. A low-pass filter connector incorporates capacitors and ferrite inductors, as needed, into the connector body. The two capacitor types commonly used in filter connectors are planar arrays and tubular capacitors.

Planar Capacitors:

The planar array is a multi-layer, multi-hole capacitor where each individual hole represents a capacitor that shares a common ground to the connector shell. Amphenol is one of the only filter connector companies that has an in-house capability to manufacture planar capacitors. Amphenol can manufacture planar arrays with mixed capacitance, multiple hole diameters to suit the many insert arrangements of military connectors, and the addition of insulated and ground lines.



Tubular Capacitors:

Filter connectors designed with a tubular capacitor are based on the need for programmability and extreme variations in capacitance. Tubular capacitors are found mostly in commercial applications where vibration and mechanical shock requirements are not as severe.

Chip Capacitors:

This design is best for filter connectors with a 'C' circuit where the current eliminates the need for an in-line ferrite bead. This technology is not as prevalent in high-end programs but can work well and where the insertion loss is required mostly at specific frequencies, or where cost is a driver.

Transient Suppression for Lightning and EMP Protection:

Protection from high voltage/high energy transients that may result from lightning, load switching, electrostatic discharge (ESD), or electromagnetic pulse (EMP) using Zener suppression diodes or MOVs. These can be incorporated into the connector body in combination with EMI filtering or alone.

Diode Protection:

Custom diode/contact assembly installed into an insert with a ground plate. This is ideal for environments requiring clamping of an extremely fast rise time transient. Each diode is individually replaceable at the factory in the event that repair is necessary.

Electrostatic Discharge (ESD) Protection:

Cylindrical and rectangular connectors can protect sensitive components from Electrostatic Discharge (ESD) without diodes, varistors, gas tubes, or "experimental" semi-conductive materials. These connectors utilize the Faraday Cage principle to shunt electrostatic discharge events to the conductive enclosure on which the connector is mounted.

CIRCULAR CONNECTORS



Mil-Spec Circular Filter Connectors:

EMI/EMP Protection Connectors offer the versatility of standard connectors with EMI/EMP protection for sensitive circuits. Internal housing of the EMI/EMP devices eliminates costly and bulky exterior discrete protection devices. Virtually all major MIL-Spec circulars can be incorporated with filter devices.



M26482 Filter Connectors:

MIL-C-26482 Series II filter connectors are designed and manufactured to meet or exceed the requirements of the Military Specification. All of Amphenol's filter connectors are intermateable and interchangeable with standard non-filtered MIL-C-26482 Series II connectors unless otherwise specified.



Circular Filter Connector Adapters:

Installation of the adapter is quick and efficient, requiring no tools, fixtures or extended downtime. Simply un-mate the existing cable harness from the receptacle; attach the coupling nut to the receptacle on the unit; then mate the cable harness to the receptacle side of the adapter.



Filtered Rhino Connectors:

The Amphenol Filtered Rhino series is designed for DC power signals with working voltages of 100V, up to a current of 500A. The products feature a 'C' filter circuit with up to 10 μ F capacitance typically providing >60dB attenuation at 1MHz.



2M Micro 38999 Filter Connectors:

Amphenol's EMI protection connectors offer the versatility of our standard 2M connectors with EMI protection to suit the demands of any application. 2M Filter Connectors offer a reduction in weight and space with the elimination of external filtering.



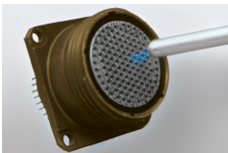
M55116 Filtered Audio Connectors:

164F Series Filtered Audio Connectors meet or exceed all MIL-DTL-55116 requirements, including mating durability, environmental sealing, and thermal cycling. They mate to standard plugs, with screw-machined contacts, passivated stainless steel shells, and high grade thermoplastic inserts.



MOV Connectors:

MOV Connectors offer the versatility of a standard connector, with transient protection for sensitive circuits, and are compatible with current filter connector assembly procedures. Internal housing of the MOV offers weight and space savings and eliminates costly and bulky exterior suppression mechanisms.



ESD Protected Connectors:

Amphenol utilizes the Faraday Cage principle in developing cylindrical and rectangular connectors which protect sensitive components from Electrostatic Discharge (ESD) without diodes, varistors, gas tubes, or "experimental" semi-conductive materials. (Human model ESD only shown in image.)



Grounded Connectors:

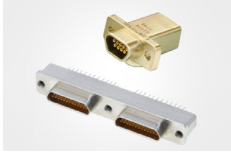
Derived from MIL-DTL-38999 connectors, Amphenol Socapex Ground Plane Connectors feature specific metallic inserts to provide an electrical continuity between the shell and contacts. They are available in composite and metallic versions.



Epoxy Backfilled Connectors and Headers:

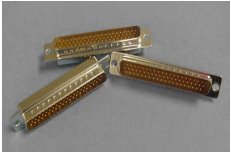
Epoxy sealed connectors are a lightweight alternative to glass sealed hermetic connectors for use in avionics and other weight-sensitive applications where a high level of sealing is required. Epoxy sealed connectors are an optimal solution in radio and vetronics applications.

RECTANGULAR CONNECTORS & BACKSHELLS



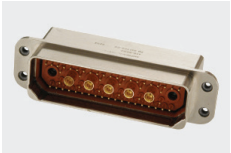
M13 - M83513 Micro-D Filter Connectors:

This connector series is a range of filtered MIL-DTL-83513 Micro-D products for military and aerospace applications. These extremely small filter connectors employ monolithic planar capacitors in a rugged, high density package. Available in a variety of filter types and mechanical configurations.



FD308 - Filtered D-Sub Connectors:

Amphenol's FD308 connectors are available in the full range of standard and high-density arrangements, either pin or socket. These connectors are supplied with fixed screw machine contacts and are available in Solder Cup, Straight or Right Angle PCB terminations.



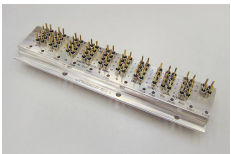
458 - Filtered M83733 Connectors:

Amphenol R58 Series are high performance, environment-resistant, rectangular connectors designed to exceed the requirements of MIL-DTL-83733. This series is well suited for military aircraft applications where shielding effectiveness is mandatory.



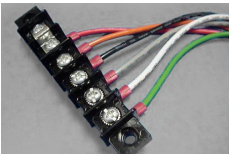
485 - Filtered ARINC Connectors:

The Amphenol 485 Series is a range of filtered ARINC 404, 600, and MIL-DTL-83527 rack and panel connectors designed to provide space and cost-effective solutions to EMC compliance issues in avionics products.



FXH - Filtered Headers:

Protect your Board-to-Board signals against radiated and conducted EMI. This header snaps into place without assembly tools and saves real estate.



FXL - Filtered Terminal Blocks:

Filter power lines against noise and transients. Close EMI windows to protect your sensitive electronics. Choose from a broad range of sizes and termination styles to suit your design.



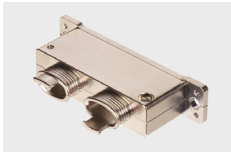
308 - Filtered M24308 D-Sub Connectors:

These connectors use a stress-isolated design without incorporating solder to allow for the rugged transfer of shock and vibration waveforms without damage to the filter elements. All sizes and termination styles are available with short lead times to meet the military and commercial aviation markets.



Environmental and Non-Environmental EMI/RFI Backshells:

Both individual and overall shielding can be terminated in this type, in addition to the cable sealing available in the Environmental Backshell. It is an ideal choice for heavy duty cabling solutions in harsh environment situations where electromagnetic and radio frequency noises are to be isolated.



Rectangular EMI Backshells:

The Amphenol Rectangular EMI backshell is designed for use on any of our rectangular connector series. Available in straight, 90 degree and 45 degree varieties, the backshell provides a reliable means of providing EMI and strain relief for harnessed connectors.



Micro-D EMI Backshells:

The Amphenol Micro-D EMI backshell series MBS is designed for use with M83513 connectors. It is a reliable means of providing EMI and strain relief for harnessed connectors.

EMI/EMP FILTER PROTECTION WORKSHEET

Use the following sections as a guide for determining EMI options and solutions

SECTION 1:

- Is there a need to meet EMC or DO-160 requirements?
- Are EMC issues, EMP or Lightning Protection Issues a concern?

SECTION 2:

- Who is the responsible person for ensuring projects meet EMC Issues?
- Who is responsible for testing systems for EMC Compliance?
- What are the current solutions used to deal with EMC problems in design?
 - Shielded cable (Section 3)
 - EMI gasketing (Section 4)
 - On-Board filtering with chip caps and inductors (Section 5)
 - EMI Backshells (Section 6)
 - Filter Connectors (Section 7)
 - Transient Protected Connectors (Section 8)

SECTION 3 - SHIELDED CABLE:

- If using shielded cable, is weight a concern? Can this be reduced and/or eliminated by using an I/O filter connector?
- Consider cabling solutions by Amphenol cable houses (Amphenol Griffith Enterprises, Amphenol SEFEE, Amphenol Ionix Systems) or Amphenol accessories (Amphenol Interconnect India backshells, Amphenol PCD/ Amphenol AirLB system attachments)

A correctly terminated connector interface could reduce emissions making the cable lighter and cheaper and could eliminate the need for screened twisted pairs.

SECTION 4 - EMI GASKETS:

- If using EMI gaskets around the I/O connector, integrating the panel into the machined connector flange can be an option. Use Amphenol Canada, Amphenol Aerospace, or Amphenol Limited to machine the connector as one piece to the back panel of the system.
- What about ground pins to provide a low impedance ground path?

SECTION 5 - ON-BOARD FILTERING:

- If using on-board filtering, does this satisfy both conducted and radiated emissions in both directions?
- Is board real estate a concern or is it desirable to reduce the board size?
 - (If so, go to Section 7 – Filter Connectors)
- If not sure, consider a filter connector.
- If using on board filtering, consider complete board assembly by Amphenol Invotec, Amphenol Printed Circuits, or Amphenol Borisch Technologies.

L filters could be combined with on-board capacitors.

A filter connector could reduce size and weight by eliminating clean and dirty areas in the equipment.

SECTION 6:

- If using backshells with the I/O connectors, whose backshells are currently used?
- Consider Amphenol Interconnect India for circular backshells and Amphenol Canada for rectangular backshells.
- Is an integrated backshell that is machined into the connector housing of special interest?

SECTION 7 - FILTER CONNECTORS:

If you have established the need to use a filter connector there are questions that need to be asked to design the right filter connector that will solve the specific EMC issues.

- What is the connector that needs to be filtered? Specific part numbers are helpful.
- What capacitance per line is required?
- Are all lines filtered the same or not? Be as specific as possible by utilizing the EMI check sheet*.
- What is the rated voltage and dielectric voltage requirement?
- What termination is needed? PC Tail, Solder cup, or Crimp?
- Are there any special dimensional constraints?
- Are there any special design features (Dual flange, Special sealing, Float mount, High DWV, Press-fit headers, etc.)?

SECTION 8 - TRANSIENT PROTECTED CONNECTORS:

This section deals with connectors that contain active devices such as diodes, metal oxide varistors (MOVs) and fuses.

- What connector needs to be protected?
- Does the solution require both filters and transient protection or just transient protection?
- What devices are preferred? Diodes, MOVs, or fuses?
- What are the ratings of the devices, i.e. power rating and breakdown voltages (can have more than 1 device in a connector)?
- Are there any dimensional constraints?

SECTION 9 - PROGRAM INFORMATION:

- What is the program and/or application being working on? This helps with knowing environmental conditions.
- Is there a target pricing to the solution? This can impact technologies used to define the solution needed.
- What are the anticipated production quantities?
- What is the time frame of the program?
- What other companies or solutions are being considered?

* To view our EMI check sheet, visit www.amphenol-aerospace.com/emi-checksheet

Contact Amphenol Military & Aerospace for more information on EMI/EMP Filter Protection Solutions.

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