GENISCO FILTER™
always on.™

Quality Management System in accordance with ISO 9001

EMI/RFI Filter Basics

How EMI/RFI Filters Work

Genisco EMI/RFI (Electromagnetic Interference/Radio Frequency Interference) Filters are designed to reject selected frequencies (or interference) that are present on a power or signal line. Our EMI/RFI filters consist of only passive elements (inductors, capacitors and in some cases resistors) in selected combinations to block Electromagnetic Interference (EMI) caused by electromagnetic induction (conducted emissions) or electromagnetic radiation (radiated emissions). When this unfavorable interference in located within the transmitted radio frequency range it is considered Radio Frequency Interference (RFI). Genisco EMI/RFI filters are made in metal housings in order to shield our filter output from exposure to any radiated interference.

Common sources of EMI/RFI interference include: electrical power lines, cords or wiring (these work as antennas to pick up or contribute to radiated interference), switching power supplies, AC motors and microprocessors. Genisco EMI/RFI filters will protect your equipment from this interference in order to prevent malfunction of electronic equipment, possible data loss and degradation of electronic equipment. EMI/RFI filters are applied to both the input and output power lines in order to ensure no external interference affects your equipment.

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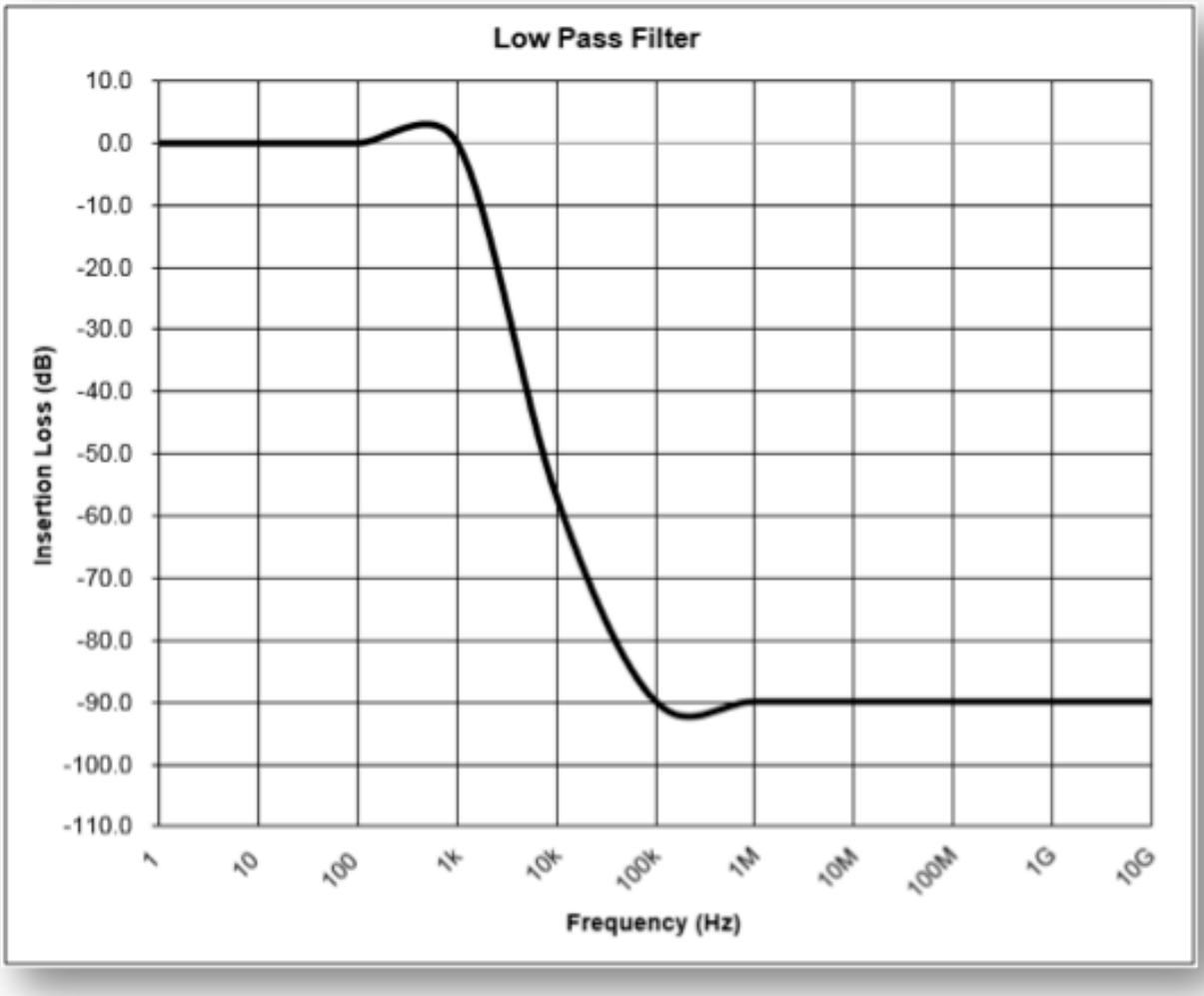
Standard EMI/RFI Filter Types

Low Pass

Low Pass filters allow lower frequency signals to pass through the circuit, but provide high impedance to high frequency signals. This attenuates (lowers the magnitude of) high frequency signals as shown in the example graph below.



Generally AC Power systems run at either 50 Hz, 60 Hz or 400 Hz, so all Genisco Power Filters are Low Pass Filters. Our filters allow the lower frequency power signals to pass through the circuit, and block the unwanted higher frequency noise.

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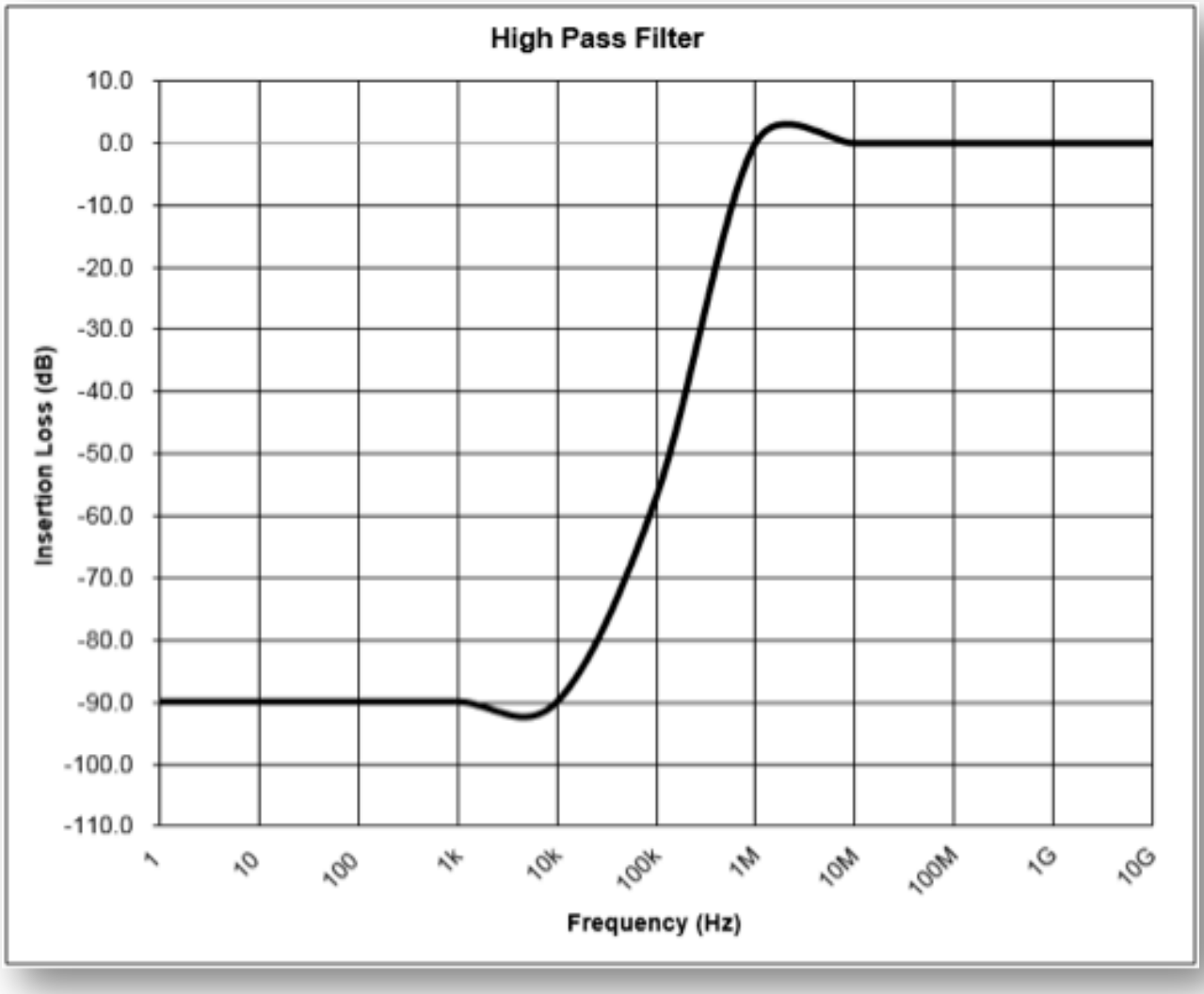
High Pass

High Pass filters allow higher frequency signals to pass through the circuit, but provide high impedance to low frequency signals. This attenuates (lowers the magnitude of) low frequency signals as shown in the example graph below.



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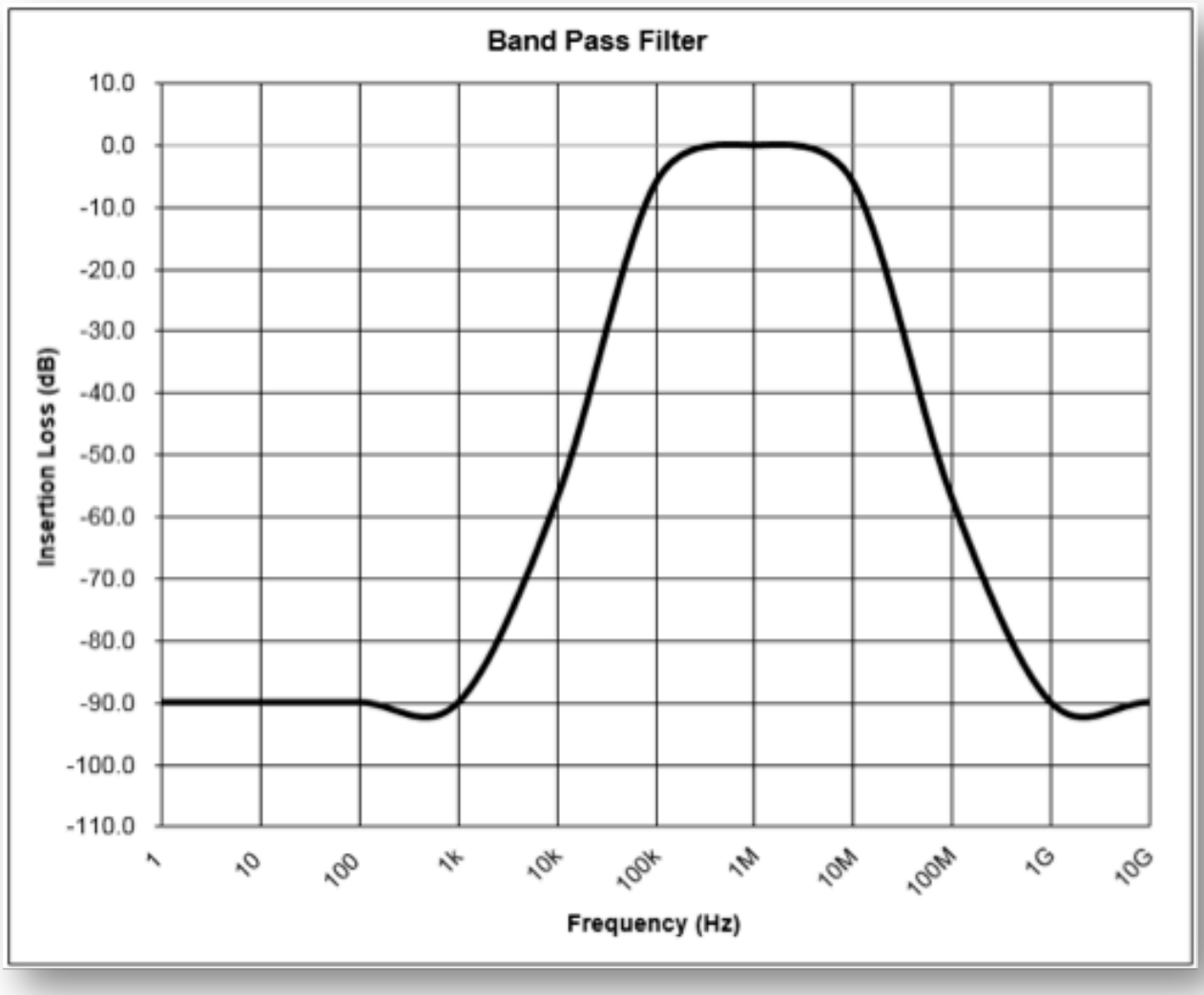
Band Pass

Band Pass filters allow signals within a certain frequency range to pass through the circuit, but provide high impedance to all other frequency signals. This attenuates (lowers the magnitude of) all other frequency signals than the ones allowed to pass as shown in the example graph below.



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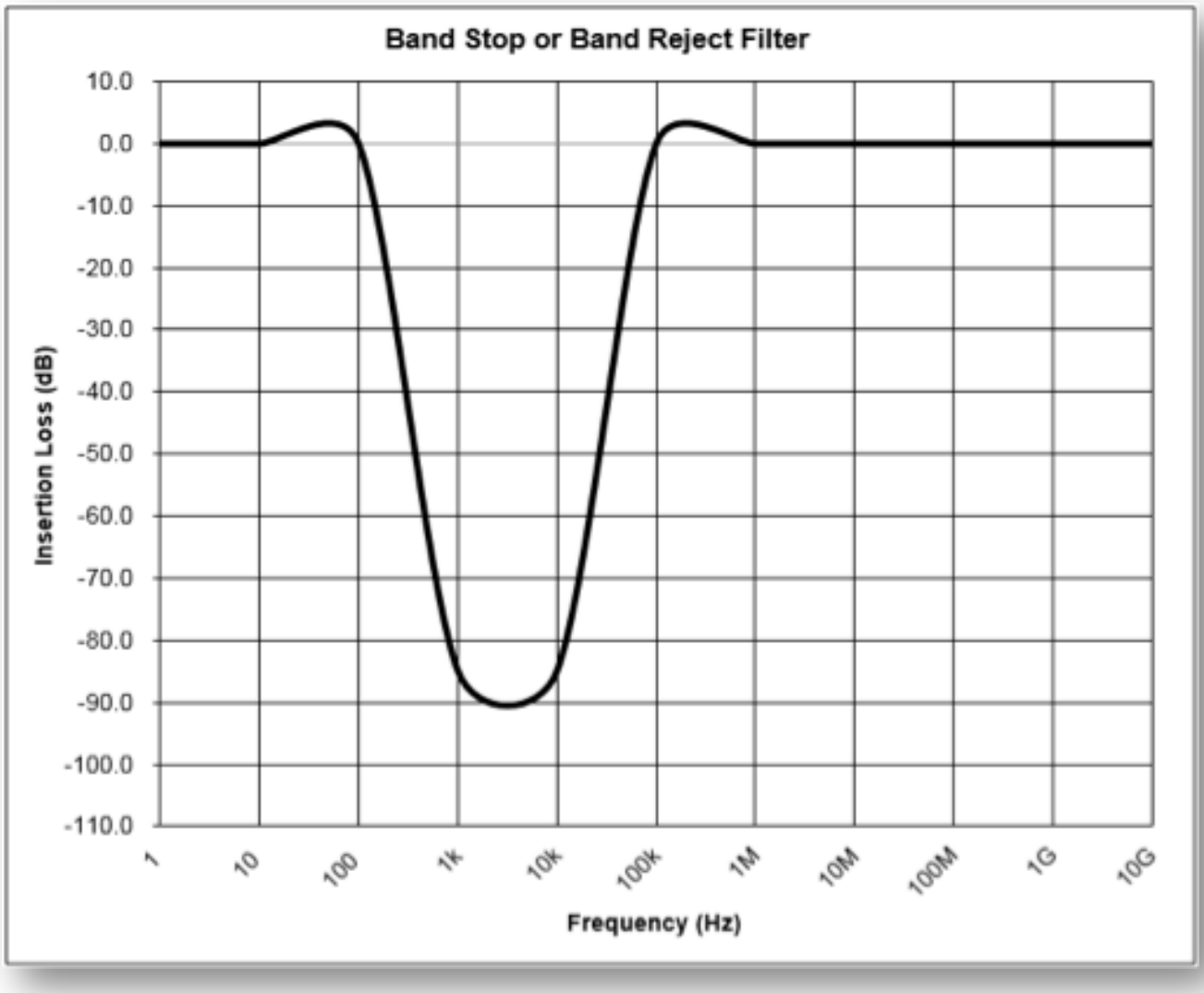
Band Stop or Band Reject

Band Stop or band Reject filters allow all signals except for a certain frequency range to



pass through the circuit, but provide high impedance to the frequency signals within a certain range. This attenuates (lowers the magnitude of) the signals within this specific frequency range as shown in the example graph below.

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EMI/RFI Filter Applications

Shielded Rooms

Shielded rooms are used in many different applications including some of the following examples: MRI rooms in Hospitals, SCIFs (Sensitive Compartmented Information Facility) utilized in Military applications, Secure Data or Server Rooms for Commercial Businesses or Electronic Test Rooms that block all interference from outside sources.

EMI/RFI Filters are designed to keep conducted high frequency noise from entering or exiting the shielded room via the power or communication lines. Genisco offers a wide variety of filters or the ability to customize the filter that will fit your shielded room application.

Energy Management

EMI/RFI Filters are used in Energy Management systems to keep emissions from affecting sensitive equipment in applications such as Smart Homes or Renewable Energy Systems. Homes generating their own power from Solar Energy utilize EMI/RFI Filters to remove the interference generated by the Inverter used to convert the DC power from the panels to the AC power. Smart Homes connect most electronic equipment in the house to one management system, which may require EMI/RFI Filtering to remove any interference that may affect your equipment.

Communication

Communications systems such as Telephone, Fire Alarm, Data Lines, PA Systems, and other General Communications require EMI/RFI filters to avoid interference on the lines. For Data and Telephone lines this interference may cause lost or corrupted data transfers, whereas in Fire Alarm or PA Systems filtering out spurious signals helps prevent false alarms or noise being projected over the alerting system.

Electronics

There are a wide variety of applications for EMI/RFI filters in electronics including Automation or Test Equipment and Commercial Electronics. Industrial Electronic Equipment including; Automation Equipment/Motion Controls, Test Equipment, Laboratory Equipment and CNCs (Computer Numeric Control) require EMI/RFI filters to protect the equipment, and also to prevent any performance issues that may arise from potential interference. Other applications of EMI/RFI filters include filtering power for Smart Appliances or Servers that may not require installation in a shielded room.

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Military/Space/Aero Electronics

The Military has been trusting Genisco filters in their applications for over 50 years. Military applications of EMI/RFI filtering range from removal of interference from Navigation, Guidance and Detection Systems to power filtering of portable SCIFs (Sensitive Compartmented Information Facility). Military as well as Commercial Aeronautical and Space vehicles utilize EMI/RFI filtering in their communication equipment to protect from data loss or corruptions.

Custom

Genisco has been making filters for over 50 years and have been customizing filters based on mechanical considerations, cutoff frequency, pass-band, insertion loss, voltage and current ratings, plus many applicable military and regulatory agency requirements.

Voltage

The first consideration is to determine the voltage of the system. When determining AC voltage you will want to consider both line-to-line and line-to-ground voltage. For Power Line Filters the voltage will normally be one of the following:

- 120/208 VAC
- 277/480 VAC
- 24-1000 VDC

Current and Number of Paths/Phases

Current rating requirements of a filter can be determined by the maximum current rating specifications of the system it's connected to. All filters for AC power systems must have a minimum of two conductive paths, of which one must be designated for the return or neutral path. When working with Single Phase AC Power a filter will be required for the power line and it's return (2 total paths), whereas Three Phase AC Power will require a filter for each of the three phase lines and the neutral (4 total paths).

A power system may specify maximum current ratings per conductive path, phase, or the system as a whole. Current requirements may range from less than 1 Amp to well over 1000 Amps. Genisco part numbers contain the current rating and number of paths/phases, so that you can easily determine a '-2x50' filter contains 2 conductive paths with 50 Amp maximum rating per path (Typically used for 1 line and 1 neutral).

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Frequency and Insertion Loss

Our filters are designed to block unwanted interference at higher frequencies, while leaving the desired power, signal or data frequencies to pass through unaffected. In the case of power-line filters the power frequency is generally 50/60 Hz or 400 Hz, and only filters that match the designated of your system should be used.

A frequency range should also be specified for the unwanted interference our filters will reject. This frequency range should be accompanied by the desired Insertions Loss or performance of the filter throughout the frequency range (in dBs). In terms of voltage level of the signal at a specified frequency, every 20 dB of attenuation moves the decimal to the left one place. For example, a 1 VAC noise signal at 14 kHz when connected to a filter that specifies 100dB at 14 kHz, will be filtered down to a 0.00001 VAC signal. Note that all measurements in dBs are calculated using a 50/50 Ohm system.

Pass-Band Impedence

For data and signal line filters, the Pass-Band Impedance of the load must be specified to insure that the filter is properly matched for data transmission. Pass Band Impedance is defined by the in-line inductance of the filter at a specified frequency. Increases the values of the inductors in a filter will cause the Pass-Band Impedance to increase, while decreases in inductor values will decrease Pass-Band Impedance.

In order to limit Pass-Band Impedance of a filter the inductor values must be properly sized. Lowering the value of the inductors will be detrimental to the performance of the filter. To maintain performance after lowering inductance will require an increase in the amount of capacitance in the filter.

Reactive or Leakage Current

Some regulatory agencies or military specifications will specify the amount of reactive current (or leakage current) that is allowed by the filter for safety purposes. Reactive Current of the filter is caused by the amount of capacitance between line and ground. Increases in the values of the line-to-ground capacitance will cause the reactive current to increase, while decreases will lower reactive current.

In order to limiting Reactive Current of a filter the capacitor values must be properly sized. Lowering the value of the capacitors will be detrimental to the performance of the filter. To maintain performance after lowering capacitance will require an increase in the amount of inductance in the filter.

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Capacitive v. Inductive Input

A filter may be designed with either capacitive or inductive input. The advantage of an Inductive Input is the limit on the effect of transients or spikes on the line as well as some EMP pulses, and better performance in real world unmatched Source/Load applications. However, Inductive input filters tend to have a higher Pass-Band impedance and tend to be more expensive than Capacitive Input filters.

Size and Weight

Size and weight of a filter is determined by the passive components that go into the filter. The size and quantity of these passive components is determined by the Current Rating (Amps) and Insertion Loss/Performance of the filter. For our power filters the cases are made of cold rolled steel, so the size of metal housing used to enclose the various sizes and quantity of components will also affect the overall weight of the filter.

Special Considerations

There is an almost unlimited list of possible special considerations in selection of a filter including Regulatory Agencies, Military Specifications, and Special requirements.

Regulatory Agency specifications may include:

- UL (Underwriters Laboratories) is a safety consulting and certification company
- FCC (Federal Communications Commission) is an independent agency of the United States government that regulates interstate and international communications by radio, television, wire, satellite, and cable in all 50 states, the District of Columbia and U.S. territories.
- CSA (Canadian Standards Association) is a non-profit standards organization which develops standards in 57 areas.
- TUV (Technischer Überwachungsverein) are German organizations that work to validate the safety of products of all kinds to protect humans and the environment against hazards.
- VDE (Verband der Elektrotechnik) is the Association for Electrical, Electronic and Information Technologies and their related sciences, technologies and applications.

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Military Specifications such as:

- MIL-PRF-15733: Performance specification filters and capacitors, radio frequency interference
- MIL-STD-202: Test Method Standard Electronic and Electrical Component Parts
- MIL-STD-220: Test Method Standard Method of Insertion Loss Measurement
- MIL-STD-461: Electromagnetic Interference Characteristics Requirements for Equipment

In addition, special requirements such as EMP (Electromagnetic Pulse) and TEMPEST (leaking emanations) must be given careful consideration. A discussion with Genisco's Engineering staff will be helpful in determining the applicability of these requirements and their effects on the design of a specific filter to meet a given application.

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