



**WEMS ELECTRONICS  
EMI FILTER GROUP**



## **Glossary of EMI Filter Terms**

**ABSORPTION LOSS:** That part of shielding effectiveness dealing with energy absorption through a metal barrier.

**ALUMINUM ELECTROLYTIC:** A capacitor that uses a thin aluminum oxide layer on pure aluminum foil as a dielectric. An electrically active solution called electrolyte is part of the cathode of the capacitor.

**ACTIVE FILTER:** A filter made up of both active and passive components. It may provide amplification, as well as attenuation.

**ATTENUATION:** A measure of filtering, expressed in decibels (dB). It is a measure of how effectively the filter reduces the strength of a given frequency. The higher the number, the better the filtering. In general, attenuation of 40 to 70 dB is a good target. Reduction in the quality or magnitude of an electrical signal. Suppression of EMI noise in the interconnect transmission path.

**APERTURE LEAKAGE:** Compromise in shielding effectiveness from holes, slits, and slots from braid, windows, cooling openings, and joints of metal boxes where EMI can get in or out.

**BAND – ELIMINATION FILTER:** A filter that rejects frequencies above and below a frequency, or frequencies, of interest.

**BANDPASS FILTER:** A filter that rejects frequencies above and below a frequency, or frequencies, of interest.

**BANDWIDTH:** The frequency interval between the upper and lower 3 dB down response of a receiver.

**BASELINE:** A document that establishes a procedure for controlling all changes to design sheets, outline drawing, cross sectional drawing, part procurement drawing, high reliability documentation and all procedures and processes, both assembly and test, used in conjunction with the manufacturing of parts to a customer's drawings.

**BOLT STYLE FILTERS:** Also referred to as Bushing Style Filters, Bolt Style Filters, and Screw Body Style Filters.

**BUTTERWORTH:** A filter network that exhibits the flattest possible response in its passband. The response is monotonic, rolling off smoothly at the rate of 6dB per octave, per pole

**BUTTON FILTER:** A cylindrical, or coaxial, style filter with a straight or nail head lead for a terminal. These filters are normally "C" or "L" circuits and are epoxy sealed on both ends.

**C FILTER:** A filter using a capacitor

**CAPACITANCE REACTANCE:** Opposition offered to the flow of alternating or pulsating current by capacitance, measured in ohms.

**CAPACITANCE:** The technically correct term for capacity. It is the measure of the amount of electrical charge stored in a capacitor expressed in farads. One farad is one coulomb of charge at one volt.



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**CHIP FILTER:** A filter specifically designed for surface mount installation.

**CHEBYSHEV:** A filter design approach providing greater selectivity (for a given number of elements) than a Butterworth design by introducing some ripple in the passband. A filter network that is designed to exhibit a predetermined passband ripple; in exchange, it provides more rapid attenuation above the cut-off (-3dB) frequency.

**CISPR:** The international special committee for EMI/RFI suppression.

**CLAMPING VOLTAGE:** The maximum voltage to which the TVS device will clip any transient voltages.

**COMMON MODE INTERFERENCE:** Interference which is present as a common potential between ground and all power lines, also referred to as asymmetric interference.

**CONDUCTED EMI:** Electromagnetic interference that exits or enters a piece of equipment via conduction on the power line.

**CORNER FREQUENCY:** The cutoff frequency.

**CORONA:** An undesirable electrical discharge resulting from ionization of gas within a capacitor. This is a particular problem with film capacitors in AC voltage conditions.

**COUPLING PATH:** The conducted or radiated path by which interfering energy gets from a source to a victim.

**CROSS MODULATION:** Energy from one transmitter that causes the modulation to change on a received signal from another transmitter.

**CROSSTALK:** Electromagnetic energy bleed across dielectric materials, for example, in twisted pair cable sets or across adjacent connector contacts, disrupting the electrical signals in each respective circuit.

**CUTOFF FREQUENCY:** The frequency which determines the end of the passband, normally the 3 dB point.

**CYLINDRICAL STYLE FILTERS:** Also referred to as Coaxial Style Filters, Mini Filters, Sub-miniature Filters, Broadband Filters, Threaded Mount Style Filters, and Button Filters.

**DECADE (FREQUENCY):** An increase or decrease in frequency by a factor of 10. 1 kHz to 10 kHz is one decade.

**DECIBEL (Db):** Convenient method of expressing the ratio of signal levels i.e. input to output.

**DIELECTRIC:** The insulating material that separates the two plates of the capacitor. Common dielectric include mica, ceramic, plastic films, tantalum pentoxide, and aluminum oxide.

**DIFFERENTIAL MODE INTERFERENCE:** Interference which is present as a potential between individual power lines, also referred to as symmetric Interference.

**DOUBLE-T FILTER:** A filter composed of two T filters. It has five elements, typically three inductors and two capacitors.



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**DPA:** Destructive Physical Analysis. A method of examining a filter or capacitor for defects, such as voids or delaminations, by cross-sectioning.

**DRAIN:** Path by which charges absorbed by a conductor move to ground in a properly grounded system.

**ELECTRIC FIELD:** A radiated wave's potential gradient in volts per meter (V/m).

**ELLIPTIC FUNCTION:** A design approach which yields maximum selectivity by introducing stopband and passband ripple.

**EMC:** Electromagnetic compatibility, the conditions under which all components of a system do not interfere with each other or with their environment.

**EMI:** Electromagnetic interference (opposite of EMC). Electromagnetic disturbance that degrades performance of electronic equipment. Same as RFI.

**EMISSION:** the releasing or sending forth of either conducted or radiated EMI produced by some electronic device.

**EMP:** Electromagnetic Pulse. A high energy electromagnetic pulse resulting from a nuclear detonation in the stratosphere.

**ESD:** Electrostatic discharge. A momentary (and unwanted) discharge of built-up electrical energy, usually from an electrically insulated object to an object with a different electrical potential.

**ESL:** Equivalent series inductance. The extent to which the capacitor acts as though there were an inductor in series with the capacitor. ESL is generally undesirable especially at high frequencies.

**ESR:** Equivalent series resistance. The extent to which the capacitor acts as a resistor when charging and discharging in an electronic circuit expressed as a resistance in series with the capacitor.

**FEED-THROUGH CAPACITOR:** A three terminal capacitor where the third terminal is grounded. The capacity is between the line passing through the capacitor and ground.

**FEED-THROUGH FILTER:** A filter designed for bulkhead mounting. All signals must "feed-through" the bulkhead.

**FERRITE:** Powdered magnetic material in form of beads, rods, and rings used to absorb EMI on wires and cables.

**FIELD STRENGTH:** Radiated voltage or current per meter corresponding to electric or magnetic fields.

**FILM CAPACITORS:** Capacitors made out of any plastic, polyester, polypropylene, and polystyrene, being the most common.

**FILTER:** An electronic circuit that offers minimum opposition to the passage of certain signals, but offers maximum opposition to others.



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**FILTER CONNECTOR:** Connector that houses contacts that provide EMI suppression in addition to its normal function or transmitting electrical energy. Filtered connectors are typically specified for high speed signal paths. Filtering is accomplished through the integration of capacitors into the contact to separate high frequency noise from low frequency signals.

**GAIN:** Ratio of output to input at a certain frequency. The filter both amplifies and attenuates if the gain is greater than one.

**GROUNDING:** A conductive path to earth designed to eliminate electrical shock by shunting away dangerous currents.

**HERF:** An acronym for High Energy Radiated Fields. This type of radiated susceptibility testing generates electric fields in excess of 1000 volts per meter to simulate close lightning strikes, normally applicable to aircraft testing.

**HI-POT:** High-potential test. A test for determining the breakdown point of insulating materials and spacing also referred to as dielectric withstanding voltage.

**HIGHPASS FILTER:** A filter that passes frequencies above a specific frequency.

**IMPEDANCE:** The sum of the resistive and reactive components in an AC circuit, which represents the total resistance of that circuit (symbol is Z).

**IMPULSE NOISE:** A transient electrical disturbance, usually repetitive.

**INDUCTANCE:** For filter connectors, inductance presents high reactance to high frequencies and low reactance to low frequencies: it passes low frequencies and blocks high frequencies

**INSERTION LOSS:** The measured signal at a given point of the circuit at a specified frequency without a filter in the circuit. This is compared to the signal level obtained at the same point with the filter inserted into the circuit.

**INSULATION RESISTANCE (IR):** The electrical resistance of an insulating material, typically measured between two conductors or a conductor and ground. The value is typically several million ohms (megohms).

**L FILTER:** A filter using an inductor (or several inductors) only.

**LC OR CL FILTER:** A filter using both a capacitor and an inductor.

**LEMP:** Lightning electromagnetic pulse. EMP caused by a lightning strike.

**LEAKAGE CURRENT:** The current that flows from the power line to ground potential when power is applied to the device in question. If the device becomes ungrounded, it could become a shock hazard.

**LINEAR POWER SUPPLY:** A power supply having an output voltage bearing a direct or linear relationship to the input voltage. Transformer power supplies with capacitive input filters are categorized as linear power supplies.



**LOWPASS FILTER:** A filter designed to pass frequencies below a specific frequency.

**MIL-STD-202:** A military specification delineating the electrical and environmental test methods for electronic parts. MIL-STD-202 is referenced in filter specifications MIL-PRF-15733 AND MIL-PRF-28861.

**MIL-STD-220:** A military specification delineating the test methods for measuring the insertion loss of a filter in a 50 ohm system. This document does not specify minimum limits and cannot be correlated to the requirements of MIL-STD-461.

**MIL-STD-461 (462, 463):** A joint service military specification that limits the level of conducted and radiated emissions (EMI) emanating from military subsystems and systems. This specification also establishes minimum levels of conducted and radiated susceptibility including EMP. EMI filters *do not* meet MIL-STD-461. EMI filters cause systems to comply with the requirements by reducing the conducted emissions.

**MIL-PRF-15733:** A general military specification for all types of radio frequency interference filters and capacitors.

**MIL-PRF-28861:** A general military specification specifically intended for EMI filters and capacitors that utilize ceramic dielectric capacitors. MIL-PRF-28861 is a more stringent specification than MIL-PRF-15733 and will eventually replace some of the filter slash sheets in MIL-PRF-15733.

**MIL-STD-790:** A military standard that defines the criteria for electronic parts reliability assurance programs which must be adhered to by manufacturers qualifying parts to specifications where established reliability is required.

**MAGNETIC FIELD:** A radiated wave's current gradient, expressed in amperes per meter (A/m).

**METAL-OXIDE VARISTOR (MOV):** A device whose resistance varies with voltage, used to suppress transient voltages. Varistor is a shortened form of variable resistor.

**MULTICIRCUIT FILTER:** A custom engineered filter assembly whose main function is to provide filtering for primary input power lines (AC and DC) and, in some cases, the output or signal lines.

**MULTILAYER CERAMIC (MLC):** A ceramic capacitors manufactured by stacking many alternating layers of ceramic dielectric and conductive plates.

**NARROWBAND:** EMI Interference whose emission bandwidth is less than the bandwidth of the EMI measuring receiver or spectrum analyzer.

**NEMP:** Nuclear electromagnetic pulses. EMP caused by a nuclear explosion.

**NOISE:** A random or persistent electrical disturbance that can obscure or reduce the clarity of quality of an electrical signal or function.

**NOTCH FILTER:** A filter designed to reject a small band of frequencies, passing the low frequencies and the high frequencies.



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**OCTAVE (FREQUENCY):** An increase or decrease in frequency by a factor of two. 6 MHz to 12 MHz is one octave. The insertion loss of a filter increases at a rate of 6 dB per filter pole per octave in the reject band. The insertion loss of a Pi circuit filter will increase by 18 dB from 6 MHz to 12 MHz

**PASSBAND:** The band of signal frequencies to which a filter offers minimum opposition.

**PASSIVE FILTER:** A filter comprised of only passive, reactive and resistive elements (resistors, capacitors, and inductors). The maximum gain of this type filter is less than one.

**PASSIVE NETWORK:** An electrical circuit comprised of passive components (resistors, capacitors, and inductors).

**PDA:** Percent Defective Allowed. The number of defective parts (failures) expressed as a percent of the lot, that are permitted for a given test or group of tests.

**PEAK IMPULSE CURRENT:** The maximum current that the TVS device can handle as the result of a transient Peak Pulse Power Dissipation. A TVS device's capability for dissipating energy. Peak pulse power dissipation is calculated by multiplying the clamping voltage by the peak impulse current ( $PPP = V_{CLAMP} \times I_{MAX}$ ).

**PI FILTER:** A filter using two capacitors and one inductor for a low-pass configuration; named after the shape of the schematic symbols.

**PLANAR CAPACITOR ARRAY:** A monolithic construction technique for capacitive filters, arrays offer a compact, low-profile form factor well suited for use in connectors. A single array can accommodate all contacts in a connector; filter values can be the same for all contacts or have different values for each contact.

**POWER CONDITIONING:** Reduction of EMI pollution on power mains by inserting filters, isolators, regulators, or an uninterruptible power supply (UPS).

**POWER LINE FILTER:** A type of filter intended to prevent power line noise from entering electrical or electronic equipment. These filters also prevent digital signals from leaking out onto the power supply line.

**RADIATED INTERFERENCE:** EMI or noise transmitted from any electrical system, from power-lines to mobile telephones.

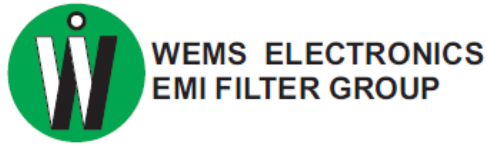
**RADIO FREQUENCY INTERFERENCE (RFI):** A special class of electromagnetic interference in which radio frequency transmissions cause unintentional problems in equipment operation.

**REACTANCE:** Resistance to changes in voltage (capacitive reactance) or current (inductive reactance). Reactance is frequency dependent.

**RFI:** Radio frequency interference. A type of EMI that occurs in the radio frequency bands.

**REFLECTION LOSS:** Shielding effectiveness due to energy reflection from impedance mismatch between incident field and metal barrier.

**REJECT BAND:** See STOP BAND.



**ROLL-OFF:** The frequency in an attenuation curve at which a filter begins to reduce the quality or magnitude of an electrical signal.

**SELECTIVITY:** A term used to describe a filter's ability to distinguish between frequencies.

**SHIELDING EFFECTIVENESS (SE):** The ratio of field strengths (absorption and reflection losses) before and after installing a shield.

**SHOT NOISE:** The noise caused by random fluctuations in the motion of charge carriers such as electrons in a conductor.

**SKIN DEPTH:** The calculated metal layer thickness through which some 63 percent of the surface current flows.

**SLOPE:** Filtering goes from no filtering to maximum filtering over a range of frequencies. The slope shows attenuation versus frequency. A steep slope is desirable, but requires more complex filtering.

**SOLDER-IN STYLE FILTERS:** Also referred to as Eyelet Style Filters and Sleeve Mount Filters.

**STOP BAND:** The band of frequencies to which a filter offers maximum opposition.

**SURGE:** A sudden voltage increase on the power mains.

**SUSCEPTIBILITY:** The ease with which an item of electronic equipment is affected by the influence of an outside RF signal source, which is being conducted or radiated in the equipment.

**SWITCHING POWER SUPPLY:** A power supply which uses transistors to switch a rectified and filtered DC voltage at 20 kHz or higher rate. This high frequency voltage is then applied to the primary winding of a transformer. An advantage of using this technique includes high efficiency in the power conversion process. Also, smaller transformers can be used, which results in a lightweight power supply.

**T FILTER:** A filter having two filter elements in the pass path and one element in the ground (filter) path. For a low-pass EMI filter, the circuit has two inductors and one capacitor. Used when both the source and load have low impedances.

**TEMPEST:** A general term for the protection and prevention of classified sensitive information being extracted electromagnetically. Electronic eavesdropping.

**TRANSFER CHARACTERISTICS:** Ratio of a filter's output to its input voltage as a function of frequency.

**TRANSFER IMPEDANCE (Zt):** The quality of cable shield performance calculated by the ratio of the coupled voltage to the surface current, in ohms per meter ( $\Omega/m$ ).

**TRANSFER FUNCTION:** A mathematical expression used in the synthesis of a filter design. Mathematically expressing the transfer characteristic.



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**TRANSIENT:** A short-duration voltage surge due to a lightning strike or other dynamic event.

**TVS:** Transient voltage suppression. Any of several techniques to suppress electromagnetic pulses by clamping voltage transients to acceptable levels. The most common TVS device used for filter connectors is the Zener diode.

**TUBULAR CERAMIC CAPACITORS:** A feed-through capacitor formed on large presses which extrude a mix of ceramic powders, organic binders and solvents. After firing, the tubes are cut to the desired length, .5 to 1.0 cm, using high speed a diamond saw. Electrodes are then applied to the OD and the ID of the tube.

**TUNABLE FILTER:** A filter having a corner, or center, frequency which can be adjusted or tuned.

**UPS:** Uninterruptible power supply.

**VOLTAGE STANDING WAVE RATIO (VSWR):** VSWR is an efficiency measurement of how radio frequency is transmitted from a power source through a transmission line, into a termination (or load).

**WAVEFORM:** For lightning events, measure of electrical transient exposure level and surge severity.

**ZENER DIODE:** A semiconductor device that allows current to flow in the forward direction like a standard diode, but also permits current in the reverse direction when the voltage exceeds a certain level. Used for transient suppression.