EMI Filters

Electro Magnetic Interference in its simplest definition is electrical 'noise' on a signal or power line. Radio Frequency Interference is Electro Magnetic Interference (EMI) which affects radio frequencies.

Modern electronics are susceptible to interference and increasingly protection against EMI is a legislative, contractual and safety requirement for telecommunications, avionics, industrial and defence equipment. Many circuits are particularly sensitive to voltage transients or spikes on signal and control lines making them acutely vulnerable to EMI.

Therefore it is essential that equipment operating within this potentially hostile environment is compliant with worldwide electromagnetic standards & legislation to provide both protection and reliability.

There are many routes to ensure that electrical and electronic equipment meets directives on electromagnetic compatibility (EMC). EMC means that equipment has the ability to function as designed, without being adversely affected by an electromagnetic interference and without being the source of such interference.

EMI can be caused by a number of factors; power supplies, high bandwidth signals, radar & radio sources, aerials, high current flows or switching, radar transmitters, motors, computer clocks, electrostatic discharge and of course natural electrical disturbances such as lightning.

The effects of EMI can vary, from image or sound degradation ('snow' or 'hum') through unexpected switching or resetting of controllers to the most severe cases which can lead to total system failure.

Anyone manufacturing, supplying or using critical components, products and systems simply cannot afford to take chances with EMI. This is especially relevant in the defence industry and aerospace where safety and reliability are paramount.

Many of the most critical systems which must be protected against EMI are used by the military but it can also be a factor in a huge range of other areas. For example:

- EMI 'noise' from the subway system caused the failure of Rubens Barichello's gearbox in the Monaco Grand Prix.
- EMI from a signal booster disrupted pilot to air traffic control communication at Luton Airport.
- EMI emanating from new trains introduced in Connecticut caused the track signals to fail.
- EMI generated by a walkie-talkie being used at the Davis-Besse nuclear power plant in Ohio disabled the plant's emergency shutdown system.

So EMI is a threat that has to be taken seriously.

Manufacturers have a dual responsibility. They must ensure that their equipment is protected against EMI. But they must also ensure that their equipment does not cause problems for other equipment or systems. That means EMI filtering is now an essential element of electrical and electronic equipment design.

EMI Protection

Protecting equipment against EMI requires effective screening. The simplest method is to enclose the equipment in a metal conductive box or 'Faraday cage'.

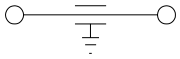
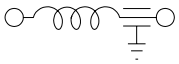
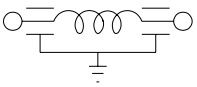
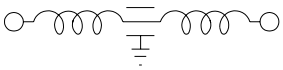
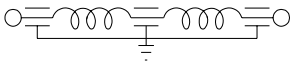
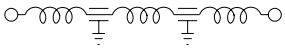
However, in practical terms most equipment requires input and output connections, power cables and signal or control wiring. This cabling can act as antennae – transmitting and receiving the interference, and introducing electrical 'noise' which in turn contaminates other wires and circuits.

This EMI contamination can be countered by capacitive (C) and inductive (L) filtering. The primary function of a filter is to attenuate or reduce the intensity of the high frequency or radio frequency (RF) currents and voltages, which would otherwise cause interference. Low pass filters are designed to pass all frequencies below a specific cut-off level.

A capacitor acts as a 'path to ground/earth' for signals but only at high frequency – which is where the 'noise' is located. Inductors reject the 'noise' back down the line, but allow DC signals to pass through. EMC filter products also incorporate Transient Voltage Suppression (TVS) in many cases to protect against harmful voltage spikes.

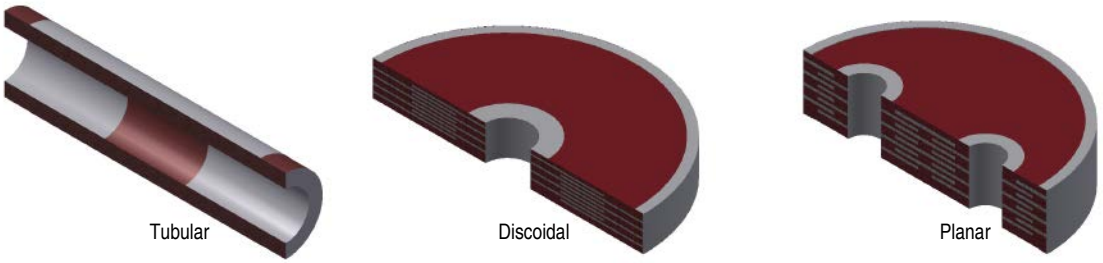
Combinations of C and L configuration filters can be specified to deliver various performance characteristics determined the level of attenuation (reduction in intensity) required at various frequencies.

To allow comparison insertion attenuation calculations assume a 50Ohm system but variations to source and load impedances of the circuit can have a great effect and should be considered when selecting the filter configuration.

CONFIGURATION	CIRCUIT CONFIGURATION	APPLICATIONS AND ADVANTAGES
C		• Higher impedence • Simple construction • Low cost
L		• Used when source and load impedances are different • Low cost • Increased filtering at high frequencies
Pi		• High impedence systems • Steep interference cut off response
T		• Low impedence systems • Steep interference cut off response
2Pi		• High impedence systems • Low cut off frequency
2T		• Low impedence systems • Low cut off frequency

Most high performance filter solutions utilise one or more of three capacitor technologies:

- single layer tubular capacitors (dry pressed and extruded)
- multilayer discoidal capacitors
- multilayer capacitor planar arrays – custom-designed solutions which achieve multiway filtering in a compact design



These translate into a range of products:

- **Filtered connectors** integrated into a custom shell or added to a standard shell. Easy and cost effective to assemble in large numbers they offer reduced weight and remove the need for bulkhead fittings.
- **Filtered modules & filter arrays** are generally bespoke designs which can utilise any filter technology including Transient Voltage Suppression (TVS) to protect against voltage spikes. They can also integrate non-filter elements in an interconnect solution. The customer benefits from ease of assembly and avoiding additional connector cost or lead-time.
- **Discrete feedthrough filters** incorporate environmental or hermetic sealing and are designed for threaded, solder-in or push-fit bulkhead mounting. They offer a good performance range and high reliability with integrated TVS protection in a wide product base.
- **Surface mount filters** for printed circuit boards offer good electrical performance across a limited range of frequencies, automated assembly and effective environmental sealing.
- **Capacitor planar arrays** are bespoke interconnect solutions with multiline capacitors located within a single ceramic disc, and offer the customer the option of specifying the electrical characteristic for each line. They are highly reliable, reduce assembly complexity and offer a solution with a comparative low cost per line.

Oxley Group - Proven EMI Protection

Oxley has established itself as a world class provider of EMI suppression capability and integrated solutions for defence, aerospace, rail, electronics and telecommunications applications, meeting the needs of global customers requiring uncompromising quality and reliability in demanding environments across military and industrial platforms.

A leading specialist in the effective suppression of electromagnetic interference through standard and advanced filtering solutions including Transient Voltage Suppression (TVS), Oxley offers customers comprehensive design, manufacturing and test facilities for electronic systems and components within the company's UK manufacturing centre and through Oxley Inc. in the USA. That represents an extensive core capability for new product development and a rapid turnaround service - even for customised designs.

Oxley filter solutions are used in a wide range of applications. For military customers that includes vehicles and weaponry including IR rifle sights, man-portable and vehicle communication systems, rocket igniter systems, military generators and aircraft ejector seat control circuits and gun control systems, Within the aerospace sector typical uses are aircraft pressure sensors, aero engine controllers, helicopter weight on ground sensors and obstacle avoidance radars. They are also found in train communication systems, security cameras, and crane remote controls, automated cruise controls in cars and in electrical test equipment.

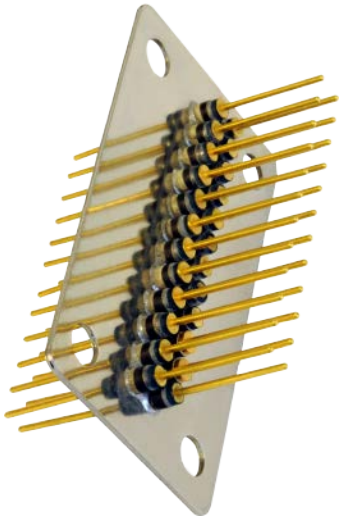
Facilities at Oxley's UK production centre include a ceramic production capability for discoidal, tubular and multiway capacitors, CNC machining, electro-plating, prototype model shop, tool room and dedicated test area. All products are tested to the most rigorous standards, with on-site high voltage and DC and AC burn-in facilities. Company approvals include: BS EN 9100: Rev C, ISO 9001:2000, ISO 14001:2004 and AS9100C.

Innovation, quality and reliability are at the heart of the business to develop powerful bespoke capabilities and deliver products that enhance the capability of platforms and systems across the world, laying the foundations of Oxley's comprehensive product portfolio:

EMI Filters - both discrete and multiline

Ceramic planar capacitor arrays

Arrays of discrete filters



Custom filter modules

Filtering of MIL standard connectors

Threaded, solder, press fit and surface mount styles

Understanding the priorities of the customer is a key element for Oxley in delivering high performance, long term reliability and stable performance over the working temperature range. The experience of manufacturing a wide range of components using standard materials and techniques combines with the expertise and insight gained developing thousands of custom-made solutions to offer outstanding customer benefits:

- Proven reliability both through design and on-site dc/ac burn-in facilities to agreed confidence levels.
- Advanced performance through the use of custom-designed ceramic and Transient Voltage Suppression.
- Minimum size and weight achieved by bespoke ceramic and Transient Voltage Suppression.
- Lower customer costs by integrating the filter capability into the connector or module.

MIL-STD-461 and EMI Filters - Explanation

The US MIL-STD-461 specification regulates the control of electromagnetic interference emissions and susceptibility of equipment. It sets requirements for the levels of emissions allowed to be exported from electrical equipment, and the susceptibility levels of equipment from external noise sources. It also provides guidelines on measuring those features.

If the levels of emissions from equipment exceed the limits set in MIL-STD-461, then they need to be attenuated (reduced in intensity) using an EMI filter. The performance of that filter across the frequency spectrum must allow the equipment emissions to be suppressed to a level low enough to allow the equipment to claim compliance with the limits of the specification. That filter performance requirement is determined by the electromagnetic signature of the equipment, and the specified limits. Compliance can then be verified by test and measurement.

Therefore no filter manufacturer can claim that their filters “meet” MIL-STD-461; because it is the equipment or platform which “meets” the specification - not the filter.