Integrating filtered connectors in airborne systems

The fact that avionic systems are volume, weight and cost sensitive has to be acknowledged in order to provide adequate solution to Electro Magnetic Compatibility (EMC) problems encountered in airborne systems.

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The last 50 years allowed much experience to be accumulated by developers of various electronic systems in relation to integrating those systems for military use. This accumulation has been made through complex processes and required failure analysis and research and the creation of mathematical models representing the mutual relations between the systems and the mutual effects upon each other. The process led to the establishment of a new engineering field: EMC (Electro Magnetic Compatibility).
EMC is the capacity of a device or a system to operate in its destined electromagnetic environment without failing. A number of EMC standards have been established and issued to regulate the mutual relations among different systems.

The standards specify the system conducted as well as radiated emission levels [Conducted Emission (CE) and Radiated Emission (RE)], the system conducted as well as radiated susceptibility [Conducted Susceptibility (CS) and Radiated Susceptibility (RS)], the line transient and the supply

line response (voltage rises and falls). Many of the earlier standards were designed for military systems, as the military arena led the technology progression and used diverse electronic systems that were required to operate in harmony. The most common military standard is MIL-STD-461 (and revisions), which has been issued by the U.S. Department of Defense. The standard updated revision is MIL-STD-461E.

The advantages of the filtered connectors are manifested by their dimension
that are identical to the standard connectors.

This allows the solution to be realized without changing
the system original physical design,

simply by replacing the existing interface connectors with filtered ones.
New EMC standards have been issued following the growing use of electronic systems in the consumer and industrial markets during the last 2 decades. A EUROCAE (the EURopean Organization for Civil Aviation Equipment) standard was issued in 1997 – ED-14D/RTCA DO-160 D. This standard is currently the most common one in use for commercial avionic equipment, and has been adopted by the military aviation industry.

Table 1: The 100MHz impedance of a spread out filter ferrite bead is 32 times higher than that of a filtered connector ferrite

bead, while the operating current is 100 times lower.

Figure 1: The measurement results of a PCB spread out filter (a product of one of the leading producers of avionic systems).

Figure 2: The measurement results of RF Immunity filtered connector.

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To provide adequate solution to Electro Magnetic Compatibility (EMC) problems encountered in airborne

systems, several facts have to be acknowledged:

- Avionic systems are extremely volume sensitive
- Avionic systems are very weight and cost sensitive. This results in little use of shielded cables as they are heavy and costly.
- The RTCA DO – 160D standard is very stringent, with some chapters even more strict than the military standards.
- The use of filtered connectors has become the ultimate solution for EMC problems in general, and for meeting the RTCA DO – 160D standard requirements in particular.

  The advantages of the filtered connectors are presented in a number of parameters:
- The filtered connectors are identical in dimensions to

standard connectors. This allows the realization of a solution without changing the original system dimensions simply by replacing the existing interface connectors with filtered ones.

- A filtered connector can tackle conduction problems (CE and CS) as well as radiation problems (RE and RS) and transient problems.
- A filtered connector simplifies the procurement and logistics operations as it requires handling a single item.
- Filtered connectors are much more efficient than the PCB spread out solutions.

A connector π filter reduces interferences at frequencies above 30MHz up to 40dB more than a similar PCB spread out filter. To demonstrate this assumption is a fact, and in response to one of our customers – a leading producer of avionic systems - we performed an experiment comparing a spread out filter with a filtered connector of similar component parameters. The results are shown in a table and with graphs.

The measurement results clearly show that the high frequency performance of the filtered connector is better, despite the fact that its ferrite bead impedance is 32 times lower at frequency of 100MHz.

Filtered connectors with diverse topologies, e.g. C, L, J, Double j, Double L, T, Pi, and Double Pi are also available. Moreover, protection against different transients can be integrated into connectors and even combined with filters while maintaining

the connector original dimensions. Common protections have an energy absorption capacity in the range of 0.1J to 0.3J levels and standoff voltages in the range of 3.3V to 30V. Moreover, a transient protection of a level higher than 0.3J can be integrated in a standard size connector when only protection against transients is required. These connectors are very flexible as special “handling” can be given to each contact, i.e. different filtering and protection level can be applied to each connector passing signal. This design flexibility allows EMC and signal integrity optimal results to be reached.

Avionic common connectors include:

- Arinc 600
- Arinc 404 (MIL-STD-81659), also available under the brand name DPX.
- MIL-C-83733, also available under the brand name DPK. These connectors, with various contact layouts, are also available in filtered and transient protected configurations, keeping their standard dimensions. Moreover, to enhance maintainability, these connectors are available with removable contacts and replaceable filtering and protection modules.

The specified protections provide an efficient solution to transients specified by RTCA/DO-160D, Section22, Change3, as follows:

- Test Levels For Pin Injection (Table 22-2)
  Level 1, waveforms3 and 4.

Level 2, waveforms3 and 4.

Level 3, waveform 3.

- Test Levels For Cable Bundles Single Stroke Tests (Table 22-3)

  Level 1, waveform 3.

  Level 2, waveform 3.

- Test Levels For Cable Bundles Multiple Stroke Tests (Table 22-4)

  Level 1, waveforms1, 2, 3, 4 and 5A.

  Level 2, waveforms2 and 3.

- Test Levels For Cable Bundles Multiple Burst Tests (Table 22-5)

  Level 1, waveform 3.

  Level 2, waveform 3.

  Level 3, waveform 3.

RF Immunity, the developer and producer of avionic filtered and transient protected connectors, also integrates SigNext UG filtering technology, which operates beyond the 1GHz range and almost linearly reduces signal interferences by up to 60dB within the frequency range.